Prepared for:

U.S. ARMY CORPS OF ENGINEERS RAMS PROGRAM
AND
BUREAU OF LAND MANGEMENT
Ely, Nevada Field Office

FINAL CLOSURE PLAN
GOLDEN BUTTE MINE SITE

USACE CONTRACT NO. DACW05-00-D-0021

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ACRONYMS

ABA	Acid-Base Accounting
ANP	Acid Neutralization Potential
AGP	Acid Generation Potential
bgs	Below Ground Surface
BLM	Bureau of Land Management
CERCLA	Comprehensive Environmental Response Compensation & Liability Act
EPA	U.S. Environmental Protection Agency
ET	Evapotranspiration
FSP	Field Sampling Plan
gpm	Gallons per Minute
GPS	Global Positioning System
HDPE	High Density Polyethylene
LAI	Leaf Area Index
LCLM	Lower Confidence Limit on the Mean
MDL	Method Detection Limits
mg/L	Milligrams per Liter
mg/Kg	Milligrams per Killogram
MSL	Mean Sea Level
MWH	Montgomery Watson Harza
MWMP	Meteoric Water Mobility Procedure
NDEP	Nevada Department of Environmental Protection
NDOW	Nevada Division of Wildlife
NNP	Net Neutralization Potential
NPR	Neutralization Potential Ratio
PQL	Practical Quantitation Limits
RAMS	Restoration of Abandoned Mine Sites
RMC	Risk Management Criteria
ROM	Run-of-Mine
RUSLE	Revised Universal Soil Loss Equation
SAR	Sodium Adsorption Ratio
Site	Golden Butte Mine Site
TDS	Total Dissolved Solids
T/KT	Tons per Killoton
TPH	Total Petroleum Hydrocarbon
USACE	United States Army Corps of Engineers
USCS	Unified Soil Classification System
WAD	Weak-Acid Dissociable
WRCC	Western Regional Climate Data Center

EXECUTIVE SUMMARY

This Final Closure Plan for the Golden Butte Mine Site has been prepared pursuant to Nevada Department of Environmental Protection regulations. The Golden Butte Mine Site is an abandoned mine located in White Pine County, Nevada, approximately 45 miles northwest of Ely, Nevada. The following mine components exist at the Site: two heap-leach pads (run-of-mine and crushed ore pads); three process ponds (run-of-mine pregnant, crushed ore pregnant, barren ponds); a waste rock pile; an open pit; two water wells; a fresh water pond; and ancillary facilities and debris. This Closure Plan presents a summary of the recent field reconnaissance and results of analyses performed on soil and water samples collected from the Site for the purpose of site characterization. Alternatives for stabilization and closure of mine source components and a proposed closure scenario based on prioritization of actions and current available funding are described. A cost estimate has been prepared for the proposed closure scenario.

Alta Gold Company began mining operations in 1988. Mining operations ceased in 1991. Leaching operations continued on a seasonal basis until 1996. Gold was extracted via a heap-leach process using cyanide. The Site was abandoned after the bankruptcy of Alta Gold. The Bureau of Land Management plans to complete reclamation activities for the Site using reclamation bond money posted by Alta Gold prior to bankruptcy.

<u>Site Characterization</u>

Results of the site characterization are as follows:

Heap-Leach Pads and Draindown Waters

Heap-leach pad materials are generally non-acidic and have low acid-generating potential. Parameters that exceeded Nevada Profile II Standards in draindown waters include:

- Antimony (between one and two orders of magnitude greater than the Nevada Profile II standard and three orders of magnitude greater than the Environmental Protection Agency drinking water standard);
- Nitrate+nitrite (as N), arsenic and sulfate (between one and two orders of magnitude above the Nevada standards); and
- Magnesium, selenium, thallium, total dissolved solids and weak-acid dissociable cyanide (within approximately the same order of magnitude as the Nevada standards).

Process Ponds

Pond waters are alkaline and contain high total dissolved solids (major cations/anions). Parameters that exceeded Nevada Profile II Standards in pond water include:

- Antimony (between two and three orders of magnitude greater than the Nevada Profile II standard, and four orders of magnitude greater than the Environmental Protection Agency drinking water standard);
- Nitrate+nitrite (as N) chloride sulfate and thallium (between two and three orders of magnitude above the Nevada standards);

- Magnesium, selenium, arsenic, and total dissolved solids (between one and two orders of magnitude above the Nevada standards); and

- Cadmium, silver, iron, weak-acid dissociable cyanide and pH (within the same order of magnitude as the Nevada standards).

Waste Rock Pile

Barren areas on the waste rock pile are generally acidic and have the potential to generate additional acidity. Low pH and high salt concentrations inhibit vegetation in barren areas. Meteoric water mobility procedure leaching test results for barren areas on waste rock exceed standards for aluminum, antimony, arsenic, beryllium, cadmium, chromium, copper, iron, manganese, nickel, selenium, zinc, fluoride, magnesium, sulfate, total dissolved solids and pH.

Vegetated areas on the waste rock pile are non-acidic and have low acid-generating potential. Meteoric water mobility procedure leaching test results for vegetated areas on waste rock exceed standards (to a lesser magnitude than the barren soil sample) for antimony, manganese, thallium, sulfate and total dissolved solids.

Total metals concentrations in the barren and vegetated soil samples on the waste rock pile were evaluated with respect to human health and wildlife risk. The metals concentrations indicate no imminent and substantial endangerment to human health. The arsenic concentration in the barren soil exceeded the BLM generic wildlife risk management criteria; however it may be argued that the risk is not substantial.

Groundwater

Groundwater in the area is alkaline, calcium/magnesium-bicarbonate type water. The Nevada Profile II standards were not exceeded in groundwater. Antimony was the only parameter that exceeded the Environmental Protection Agency drinking water standard (by approximately one order of magnitude).

Borrow Source Investigation

Approximately 15,000 cubic yards of borrow source material was identified on-site, although more colluvial material is available, if necessary. Two, on-site borrow sources were classified as clayey-gravels with hydraulic conductivities of 6.2×10^{-4} cm/s (BS-02) and 2.5×10^{-4} cm/s (BS-03), respectively. There is an unlimited supply of silt material at an off-site borrow source (BS-01), although this material lacks plasticity and may be unsuitable for cover material. The off-site silt material was classified as a silty-gravel with a hydraulic conductivity of 1.2×10^{-4} cm/s. All three borrow sources are suitable for plant growth.

<u>Proposed Reclamation Plan</u>

The primary objectives of the reclamation strategy are to provide physical and chemical stabilization of mine source components to help ensure that waters of the State are not degraded and that environmental risk factors are addressed and minimized to the extent practicable. Other reclamation objectives include protecting public safety, providing a final landform compatible with natural surroundings and promoting revegetation. For each component listed below, a preferred reclamation alternative is presented.

Heap-Leach Pads and Draindown Water

Heap leach pads will be regraded to 3(horizontal) : 1(vertical) slopes, covered with 18-inches of borrow material and revegetated. Draindown water from the pads will be routed to the crushed ore pond, which will be converted to an evapotranspiration basin. A leachfield will be designed adjacent to the basin to accommodate contingency overflow from the basin.

Process Ponds

Leachate from sludges from the run-of-mine, crushed ore and barren ponds will be tested for Nevada Profile II parameters. Water from the ponds will be spray-evaporated onto the pads for reduction and disposal. The run-of-mine sludges will be left in place inside the liner for permanent containment. The run-of-mine pond will also act as the landfill site for uncontaminated wastes. The barren pond will be used to dispose of sludges from the crushed ore pond and potentially-contaminated soils from the diesel tank area. The crushed ore pond will be converted to an evapotranspiration basin, as noted above. Liners of the run-of-mine, barren and fresh water ponds will be folded in and buried. The areas will then be regraded and revegetated.

Waste Rock Pile

No action is proposed for the waste rock pile at this time due to budgetary constraints and based on a prioritization analysis of reclamation alternatives for the Site.

Facility Debris Containment

Recyclable materials will be stockpiled for salvage. Uncontaminated materials will be placed in the run-of-mine pond for permanent disposal. Contaminated soils will be placed in the barren pond for permanent disposal, if required.

Open Pit

Additional berms and signs will be installed around the pit, as directed by Bureau of Land Management.

Water Wells

Water rights to the wells have transferred ownership. No action is proposed.

Post-Closure Monitoring

Post-closure monitoring will consist of quarterly Site visits over a three-year period following closure. Water sampling, flow measurements and water level measurements will be performed at the evapotranspiration basin, as required, during each visit.

Reclamation Cost Estimate

The total reclamation cost estimate is approximately $738,000. This estimate does not include waste rock pile reclamation or an environmental assessment.

1.0 INTRODUCTION

This Final Closure Plan for the Golden Butte Mine Site (Closure Plan) has been prepared pursuant to Nevada Department of Environmental Protection (NDEP) regulations as presented in *Preparation Requirements and Guidelines for Permanent Closure Plans and Final Closure Reports* (NDEP, 2001). This Closure Plan presents a summary of the recent field reconnaissance and results of analyses performed on soil and water samples collected from the Golden Butte Mine Site for the purpose of site characterization. Alternatives for stabilization and closure of mine source components, and a proposed closure scenario based on prioritization of actions and current available funding are described herein. A cost estimate has been prepared for the proposed closure scenario.

1.1 SITE LOCATION AND DESCRIPTION

The Golden Butte Mine Site (the Site) is an abandoned mine located in White Pine County, Nevada, approximately 45 miles northwest of Ely, Nevada within the Basin and Range physiographic province. The Site is located on the western slope of the Cherry Creek Range in Butte Valley (see Figure 1-1, *General Site Location*), at elevations ranging from approximately 6,650 to 7,180 feet above mean sea level (MSL). Access to the Site is via Nevada State Highway 93 and dirt roads through the town of Cherry Creek. The Site is entirely located on public lands administered by the Bureau of Land Management (BLM). A site map is provided in Figure 1-2, *Site Layout*, which presents the layout of mine facilities. The following mine components exist at the Site:

- Two Heap-Leach Pads (run-of-mine (ROM) and crushed ore)
- Three Process Ponds (ROM pregnant, crushed ore pregnant and barren)
- Waste Rock Pile
- Open Pit
- Two Water Wells
- Fresh Water Pond
- Ancillary Facilities and Debris

No naturally-occurring surface water exists near the project area with the exception of a seep located and flowing into the open pit (the ponds were constructed as part of the facility).

1.2 SITE HISTORY

The original co-owners of the Golden Butte Mine were Silver King Mines and Pacific Silver Corporation. Alta Gold Company was formed by a merger between the original co-owners of the project and began mining operations at the Site in 1988. Mining operations ceased in 1991. Leaching operations continued on a seasonal basis until 1996.

Gold was extracted via a heap-leach process using cyanide and the resulting gold-containing (pregnant) solutions were collected in the pregnant leach ponds. The pregnant solutions were then pumped through carbon beds to extract gold and the remaining (barren) solutions were piped to the barren pond. The barren solutions were then recycled back to the heap-leach pads.

No mining or processing activities are presently occurring at the Site. The Site was abandoned after the bankruptcy of Alta Gold. The BLM plans to complete reclamation activities for the Site using reclamation bond money posted by Alta Gold prior to bankruptcy. The Site is visited periodically by BLM and Nevada Division of Wildlife (NDOW) staff to monitor conditions.

1.3 PREVIOUS RECLAMATION ACTIVITIES

In 1995, reclamation was initiated under the direction of the *Golden Butte Project Reclamation Plan* (Alta Gold, 1993); however, due to bankruptcy, Alta Gold did not complete reclamation. Reclamation tasks that were undertaken by Alta Gold included re-contouring and seeding of the waste rock pile and rinsing of both heap-leach pads. Vegetation is currently present on approximately 83 percent of the waste rock pile.

In addition to the revegetation and rinsing activities, Alta Gold developed a design and application for a leachfield and treatment plant pond (bioreactor). This system was proposed as a permanent and final process to dispose of draindown solutions from both heap-leach pads. The design and technical approach were not approved by the NDEP (NDEP, 1998). In April 2000, the *Golden Butte Leachfield Design Report* (Alta Gold, 2000) was submitted to the NDEP. This report was not reviewed or commented on by the NDEP.

1.4 CORPS OF ENGINEERS RAMS PROGRAM

The United States Army Corps of Engineers (USACE) established the Restoration of Abandoned Mine Sites (RAMS) program in 1998 to assist in restoration and remediation of non-coal, abandoned mines. The RAMS program is funded by federal appropriations through the USACE Civil Works and addresses environmental and water quality problems caused by drainage and related activities from abandoned mines. The program supports activities and priorities of Federal, State, Tribe and nonprofit entities.

The RAMS program is managed through three regional business centers, Western, Mid-Continent, and Appalachian, each of which is made up of multiple USACE Districts. The current work for the Golden Butte Mine is being coordinated by the Sacramento and Omaha Districts of the USACE and the Ely Field Office of the BLM.

1.5 CLOSURE PLAN ORGANIZATION AND SCOPE

Components of this Closure Plan were designed based on the current understanding of Site conditions, recent field reconnaissance and both recent and historic analytical data from the Site. This Closure Plan is divided into six sections and ten appendices. Site history and a general description of mine facilities are provided in this section (Section 1.0). Pre-existing geologic, hydrologic and climate information for the Site are provided in Section 2.0. A summary of the recent field activities and current site characterization results are presented in Section 3.0. Section 4.0 presents an overview of proposed conceptual closure design. The closure cost estimate is provided in Section 5.0. References are presented in Section 6.0. The following appendices containing raw data and supporting information are attached:

Appendix A - Field Documentation and Photographs
Appendix B - Analytical Data Reports
Appendix C - Geotechnical Laboratory Reports
Appendix D - Hydraulic Parameter Laboratory Reports
Appendix E - Historic Water Quality Analytical Data
Appendix F - Pond Overflow Evaluation
Appendix G - Heap-leach Pad Regrade Design
Appendix H - SoilCover Model Results
Appendix I - Nevada BLM Revegetation Information
Appendix J - Closure Cost Estimate Details

The following components are addressed in the scope of this Closure Plan:

Heap-Leach Pads and Draindown Waters

- Geochemical characterization of heap-leach pad materials and draindown water quality
- Final configuration design of heap-leach pads (re-contouring to 3(horizontal (H)) : 1(vertical (V)) slopes)
- Soil cover design for heap-leach pads, based on SoilCover modeling, and revegetation
- Fluid management system design to collect heap-leach pad draindown water
- Design of evapotranspiration (ET) basin in crushed ore pond for handling draindown water
- Infiltration field design for handling potential overflow from ET basin

Process Ponds

- Sludge testing in ROM, crushed ore and barren ponds and development of a containment strategy
- Removal/disposal of pond water and transfer of sludges, as necessary
- Decommissioning of the ROM, barren and fresh water ponds

Waste Rock Pile

- Mapping and testing of barren (i.e., non-vegetated) areas on the waste rock pile
- Design of appropriate soil amendments, soil cover and revegetation for barren areas
- Screening-level risk evaluation of metals concentrations in barren area soils

Groundwater

- Water quality analysis of upgradient groundwater

General

- Identification and testing of soil borrow source material that may be used for reclamation
- Development of a post-closure monitoring and inspection plan
- Removal of concrete pads and miscellaneous construction debris to an on-site landfill
- Containment of soils from the diesel tank/pad area that may potentially be impacted by total petroleum hydrocarbons (TPH)
- Open pit safety

2.0 SITE DESCRIPTION

This section provides background information including a general site description and a summary of past activities.

2.1 CLIMATE

Precipitation records were obtained from the Western Regional Climate Data Center (WRCC). On average, the area receives approximately eight to 12 inches of rain per year. Precipitation at Ely, Nevada has averaged 9.23 inches annually from 1897 to 2000. The 100-year rainfall event is estimated at 2.8 inches over a 24-hour period. Most precipitation occurs during the winter and spring months. The average annual minimum and maximum temperatures from Ely, Nevada are 28.2 and 61.0 degrees Fahrenheit, respectively, and the pan evaporation rate is 48 inches. Average annual potential evaporation based on pan evaporation data from Ruby Lake for 1948 through 2000 is 46 inches (Shevenell, 1996). Ruby Lake is located approximately 30 miles northwest of the Site. The Site is therefore subject to 30 to 40 inches per year of net evaporation.

2.2 GEOLOGY

The southern Cherry Creek Range consists of Cambrian through Pennsylvanian miogeosynclinal strata with very minor amounts of Tertiary volcanics. The geologic units strike generally north-south, as does most of the faulting in the area. The bedding of the geologic units generally dip westward. Recent interpretation of the faulting indicates that it consists of either high- or low-angle normal faults with approximately 200 percent extension. The project area is underlain by Devonian Guilmette Limestone through Mississippian Chainman Shale. The northern half of the project area is comprised of the Guilmette Limestone and jasperoid that occurs at or near the contact with the overlying Pilot Shale. The ore deposit occurs near the contact of the Guilmette Limestone and jasperoid (silicified limestone) and the Pilot Shale. The mineral stibnite (Sb_2S_3) is a common accessory mineral associated with the ore deposit and related alteration. This results in elevated concentrations of antimony (Sb) in the ore and is likely the source of antimony in Site waters (including draindown waters from the heap-leach pads). The overlying Pilot Shale, while generally calcareous, contains thin fissile plates of black, non-calcareous shale that likely contributes to acidic and acid-generating areas observed in the waste rock pile. Porphyritic latite volcanic rocks form the low hills immediately north and west of the Site. Also, a rhyolite dike intrudes the limestone south of the project area.

Well borings advanced in the processing area indicate that the Site is underlain by a layer of alluvium that thickens from 60 feet on the eastern portion of the Site to greater than 300 feet to the west, below which an unaltered porphyritic latite volcanic rock is encountered (mentioned above). A shallow, low-permeability caliche layer has been observed within the soil horizon that has formed on the alluvium.

2.3 SURFACE WATER AND GROUNDWATER

There is no naturally-occurring perennial surface water near the project area, with the exception of a seep that exists in the pit and flows down into the pit. Some movement by the highwall has covered portions of the flow channel. There is evidence of use of this seep by mule deer and mourning doves (NDOW, 2003). The existing on-site ponds were constructed for mine operations. Topographic mapping of the Site indicates that drainage channels exist in the vicinity of the pads that may carry seasonal and/or intermittent flows (shown on Figure 1-2).

During Site operations, five well borings were drilled to depths of between 300 and 385 feet below ground surface (bgs) in the heap-leach pad area to locate mine-process water. These borings extended into the volcanic rock below the alluvium, but no water was encountered. However, groundwater was encountered in two other borings located approximately 0.5 miles upslope from the heap-leach pads and 1.5 miles west of the heap-leach pads. These borings were converted to the East and West Water Wells, respectively, and are described below. The locations of these wells are shown on Figure 1-2. The closest drinking water supply well is 12 miles away in the Steptoe Valley.

The geologic log for the East Water Well indicates 60 feet of alluvium overlying fractured to more competent volcanic rock to a total depth of 220 feet. Based on the well completion forms in 1988, static groundwater was recorded at 60 feet bgs at the contact between alluvium and volcanics (Alta Gold, 2000). Additionally, the water level in the East Water Well was measured at 41.6 feet (below top of casing) on November 5, 2002. It is assumed that meteoric water infiltrates through the alluvium and saturates the fractured volcanic rock below.

The geologic log for the West Water Well reports various types of alluvium for the entire length of the boring, with no volcanic rocks encountered (the total depth of boring was 300 feet bgs). Static groundwater was recorded at 70 feet bgs on the well completion form (Alta Gold, 2000). This well was able to provide a sufficient quantity of water to the mine whereas the East Water Well produced insufficient quantities of water for mine processes.

3.0 SITE CHARACTERIZATION

Sampling was performed at the Site, as described in the *Final Work Plan, Golden Butte Mine Site Investigation* (Final Work Plan) (MWH, 2002). Sampling was conducted during the week of 4 November 2002 and was used to characterize the soils, mine materials and water quality at the Site. Soil and mine material samples were collected from potential borrow areas, heap-leach pads and the waste rock pile. Water samples were collected from the crushed ore and ROM pad draindown waters, three facility ponds and the East Water Well. A summary of the sampling schedule is shown in Table 3.1, *Site Characterization Sampling Schedule*. Sample locations are presented on Figure 3-1, *Soil and Water Sample Locations*. Sampling parameter lists are shown in Table 3.2, *Soil/Rock Sample Testing and Analyses* and Table 3.3, *Surface Water and Groundwater Analytical Data*. Appendix A contains field documentation and photographs from the November 2002 field work.

TABLE 3.1
SITE CHARACTERIZATION SAMPLING SCHEDULE

Location	Sample Quantity	Sample Parameters
Heap-Leach Pads (ROM and crushed ore)	2 – Soil/Rock (LP-CO, LP-ROM)	Agronomic Parameters Geotechnical Parameters Geochemical Analyses Hydraulic Parameters Total Metals Analyses
Heap-Leach Pad Draindown (ROM and crushed ore)	2 - Water (RD-01, CD-01)	Field Parameters Flow Nevada Profile II Parameters Total Cyanide
Ponds (ROM, crushed ore, barren)	3 - Water (ROM-01, CO-01, BP-01)	Field Parameters Water Level Nevada Profile II Parameters Total Cyanide
Waste Rock Pile (Barren and vegetated areas)	2 – Soil/Rock (WRB, WRV)	Agronomic Properties Geochemical Analyses Total Metals
East Water Well	1 - Water (EW-01)	Field Parameters Water Level Nevada Profile II Parameters Total Cyanide
Borrow Source Material	3 - Soil (BS-01, BS-02, BS-03)	Agronomic Parameters Geotechnical Parameters Hydraulic Parameters Total Metals Analyses

The following sections summarize sampling procedures and results, as follows:

Section 3.1 - Heap-Leach Pads and Draindown Waters
Section 3.2 - Process Ponds
Section 3.3 - Waste Rock Pile
Section 3.4 - Groundwater
Section 3.5 - Borrow Source Investigation

Overall, data quality met project objectives for site characterization. Data quality objectives are discussed in detail in the Quality Assurance Project Plan (QAPP), included in the Final Work Plan (MWH, 2002). There were a few minor issues related to data usability. As noted in Table 3.3, the method detection limit (MDL) for beryllium (0.005 mg/L) is above the Nevada Profile II standard (0.004 mg/L). However, because it is only slightly exceeding the standard, data usability is not considered to be significantly affected.

TABLE 3.2 SOIL/ROCK SAMPLE TESTING AND ANALYSES GOLDEN BUTTE CLOSURE PLAN				
AGRONOMIC TEST PARAMETERS				
Parameter	**Units**	**Parameter**	**Units**	
Soil pH	s.u.	Bicarbonate phosphorus	ppm	
Electrical conductivity	umhos/cm	Exchangeable potassium	ppm	
Organic matter	ppm	Exchangeable magnesium	ppm	
Free lime	--	Exchangeable calcium	ppm	
Nitrate-N	ppm	Exchangeable and soluble sodium	ppm	
Available nitrogen	lbs/A	Sodium Adsorption Ratio	ppm	
Sulfate-Sulfur	ppm			
GEOTECHNICAL TEST PARAMETERS				
Test	**Method**			
Grain Size Analysis (including hydrometer)	ASTM D421 and D422			
GEOCHEMICAL ANALYSES				
Test	**Parameters**			
Acid-Base Accounting (ABA)	Sulfide-S, Acid Neutralization Potential (ANP), Acid Generating Potential (AGP), Net Neutralization Potential (NNP)			
MWMP	Nevada II Profile Parameters and Total Cyanide			
Paste pH	Paste pH			
HYDRAULIC TEST PARAMETERS				
Test	**Parameters**			
Initial Moisture Content	Moisture Characteristic Curve			
Dry Bulk Density	Saturated Hydraulic Conductivity			
Total Porosity	Calculated Unsaturated Hydraulic Conductivity			
TOTAL METALS ANALYSES				
Parameter	**Fraction**	**Method**	**Detection Limit**	**Units**
Antimony	Total	EPA 6020, ICP-MS	0.02	mg/kg
Arsenic	Total	EPA 6010B, ICP	0.1	mg/kg
Cadmium	Total	EPA 6010B, ICP	0.05	mg/kg
Copper	Total	EPA 6010B, ICP	0.1	mg/kg
Lead	Total	EPA 6010B, ICP	0.1	mg/kg
Manganese	Total	EPA 6010B, ICP	0.1	mg/kg
Mercury	Total	EPA 7470, CVAA	0.02	mg/kg
Nickel	Total	EPA 6010B, ICP	0.1	mg/kg
Selenium	Total	EPA 6010B, ICP	0.2	mg/kg
Silver	Total	EPA 6010B, ICP	0.05	mg/kg
Zinc	Total	EPA 6010B, ICP	0.1	mg/kg
Notes: ROM = Run of Mine MWMP = Meteoric Water Mobility Procedure CO = Crushed Ore WR = Waste Rock				

TABLE 3.3
SURFACE WATER AND GROUNDWATER ANALYTICAL DATA
GOLDEN BUTTE CLOSURE PLAN

ANALYTE	METHOD	UNITS	Nevada Profile II Standards	051102-EW-01	051102-BP-01	051102-CO-01	061102-ROM-01	061102-RD-01	061102-CD-01
				11/5/02	11/5/02	11/5/02	11/6/02	11/6/02	11/6/02
Aluminum, dissolved	M200.7 ICP	mg/L	0.05 - 0.2	0.03 U	0.8 U[2]	1.2 B	0.03 U	0.03 U	0.03 U
Antimony, dissolved	M200.8 ICP-MS	mg/L	0.146 (0.006 EPA)[1]	**0.016**	**7.9**	**15.7**	**15**	**4.5**	**9.2**
Arsenic, dissolved	M200.8 ICP-MS	mg/L	0.05	0.009 B	**0.12**	**0.12**	**0.3**	**0.093**	**0.113**
Barium, dissolved	M200.7 ICP	mg/L	2.0	0.186	0.011	0.023	0.018	0.023	0.021
Beryllium, dissolved	M200.8 ICP-MS	mg/L	0.004	0.0005 U	0.005 U[3]	0.005 U[3]	0.005 U[3]	0.001 U	0.001 U
Bismuth, dissolved	M200.7 ICP	mg/L	ns	0.1 U	0.1 B	0.1 U	0.1 U	0.1 U	0.1 U
Boron, dissolved	M200.7 ICP	mg/L	ns	0.14	0.78	1.17	1.9	0.53	0.6
Cadmium, dissolved	M200.8 ICP-MS	mg/L	0.005	0.0006 B	0.005 B	**0.007 B**	0.005 U	0.001 U	0.001 U
Calcium, dissolved	M200.7 ICP	mg/L	ns	64.7	214	565	110	171	359
Chromium, dissolved	M200.7 ICP	mg/L	0.1	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Cobalt, dissolved	M200.7 ICP	mg/L	ns	0.01 U	0.48	1.24	1.11	1.03	0.76
Copper, dissolved	M200.7 ICP	mg/L	1.3	0.01 U	0.05 B	0.01 B	0.01 B	0.01 U	0.01 B
Gallium, dissolved	M200.7 ICP	mg/L	ns	0.1 U	5 U	2 U	2 U	0.5 U	0.5 U
Iron, dissolved	M200.7 ICP	mg/L	0.3 - 0.6	0.02 B	0.3 U	**0.8 B**	0.05 U	**0.32**	**0.34**
Lead, dissolved	M200.8 ICP-MS	mg/L	0.015	0.0006	0.005 U	0.005 U	0.005 U	0.001 U	0.001 U
Lithium, dissolved	M200.7 ICP	mg/L	ns	0.02 U	0.96	0.48	0.47	0.1 B	0.12
Magnesium, dissolved	M200.7 ICP	mg/L	125 - 150	31.3	**1600**	**756**	**614**	**178**	**273**
Manganese, dissolved	M200.7 ICP	mg/L	0.05 - 0.10	0.005 U	0.1 U	0.005 U	0.005 U	0.018 B	0.048
Mercury, dissolved	M245.1 CVAA	mg/L	0.002	0.0002 U	0.0016	0.0002 U	0.0002 U	0.0006 B	0.0004 B
Molybdenum, dissolved	M200.7 ICP	mg/L	ns	0.01 U	1.04	0.56	0.71	0.16	0.17
Nickel, dissolved	M200.7 ICP	mg/L	0.1	0.01 U	0.08	0.01 U	0.01 U	0.01 U	0.01 U
Potassium, dissolved	M200.7 ICP	mg/L	ns	5.8	249	95.3	76.6	15.2	25
Scandium, dissolved	M200.7 ICP	mg/L	ns	0.1 U	5 U	2 U	2 U	0.5 U	0.5 U
Selenium, dissolved	M200.8 ICP-MS	mg/L	0.05	0.008 U	**0.50**	**0.29 B**	**0.21 B**	0.04 B	**0.09**
Silver, dissolved	M200.7 ICP	mg/L	0.1	0.005 U	**0.3 B**	0.1 U	**0.6**	0.03 U	0.03 U
Sodium, dissolved	M200.7 ICP	mg/L	ns	41.7	9370	5790	5630	1240	1700
Strontium, dissolved	M200.7 ICP	mg/L	ns	0.29	3.14	3.94	1.59	0.94	1.62
Thallium, dissolved	M200.8 ICP-MS	mg/L	0.002	0.00008 B	0.177	**0.058**	**0.035**	**0.0033**	**0.0058**
Tin, dissolved	M200.7 ICP	mg/L	ns	0.1 U	3 U	2 U	0.5 U	0.2 U	0.5 U
Titanium. dissolved	M200.7 ICP	mg/L	ns	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Vanadium, dissolved	M200.7 ICP	mg/L	ns	0.005 U	0.005 U	0.005 U	0.017 B	0.018 B	0.005 U
Zinc, dissolved	M200.7 ICP	mg/L	5.0	0.06	0.3 U	0.01 U	0.01 U	0.01 U	0.01 U
pH (lab)	M150.1	units	6.5 - 8.5	7.9	**8.8**	**8.9**	**9**	7.9	7.9
Total Alkalinity	SM2320B	mg/L	ns	240	587	117	384	200	187
Bicarbonate as CaCO3	SM2320B	mg/L	ns	240	587	117	336	200	187
Carbonate as CaCO3	SM2320B	mg/L	--	2 U	2 U	2 U	48	2 U	2 U
Hydroxide as CaCO3	SM2320B	mg/L	--	2 U	2 U	2 U	2 U	2 U	2 U
Chloride	M325.2	mg/L	250 - 400	43	**2220**	**600**	**600**	118	198
Cyanide, total	M335.4	mg/L	--	0.01 U	1.3	0.35	0.35	1.1	0.97
Cyanide, WAD	SM4500-CN I	mg/L	0.2	0.01 U	**0.56**	0.14	**0.23**	**0.39**	0.15
Fluoride	SM4500F-C	mg/L	2.0 - 4.0	0.2 B	0.2 B	0.3 B	0.5 B	0.4 B	0.3 B
Nitrate/Nitrite as N	M353.2	mg/L	10	2.26	**3250**	**670**	**480**	**180**	**230**
Phosphorus, total	M365.1	mg/L	ns	0.05 U	1.05	0.02 B	0.03 B	0.03 B	0.14
Sulfate	M375.3	mg/L	250 - 500	60	**20800**	**15300**	**12700**	**3050**	**4680**
TDS	M160.1	mg/L	500 - 1000	420	**43800**	**26400**	**21300**	**5530**	**8300**
Cation-Anion Balance	Calculation	%	--	4	4.7	1.2	2.5	4.5	3.6

TABLE 3.3
SURFACE WATER AND GROUNDWATER ANALYTICAL DATA
GOLDEN BUTTE CLOSURE PLAN

ANALYTE	METHOD	UNITS	Nevada Profile II Standards	051102-EW-01	051102-BP-01	051102-CO-01	061102-ROM-01	061102-RD-01	061102-CD-01
				11/5/02	11/5/02	11/5/02	11/6/02	11/6/02	11/6/02

Notes:
Shaded cell indicates exceedence of Nevada Profile II Standards
1. The EPA drinking water standard for antimony is 0.006 mg/L
2. The MDL for aluminum in sample 051102-BP-01 is above the Nevada standard
3. The MDL for beryllium is slightly above the Nevada standard
051102-EW-01 East Water Well
051102-BP-01 Barren Pond
051102-CO-01 Crushed Ore Pond
061102-ROM-01 Run-of-Mine Pond
061102-RD-01 Run-of-Mine Draindown
061102-CD-01 Crushed Ore Draindown
U Value not detected at or above the MDL. Value shown is MDL
B Value detected below the PQL and above the MDL. Value shown is estimated.
MDL Method Detection Limit
PQL Practical Quantitation Limit
ns Analyte on Nevada Profile II List. No standard.
-- Not on Nevada Profile II List.

The aluminum concentration in the barren pond sample (BP-01) is not useable for comparison to the Nevada Profile II standard because the MDL is above the standard; however, this data is still useable for characterizing the pond water, which is the data quality objective for this work.

3.1 HEAP-LEACH PADS AND DRAINDOWN WATERS

Heap-leach pads were constructed with a double-liner system. The primary liner for the heap-leach pads was an 80-mil high-density polyethylene (HDPE) material with thermally welded seams. Underlying the liner is a 12-inch thick layer of compacted silt that was placed in two, six-inch thick lifts and compacted to a permeability of 10^{-6} cm/sec.

One composite sample of the heap-leach material was collected from the near-surface (three to 24 inches below grade) from each of the ROM and crushed ore pads. Samples were analyzed for the geochemical, geotechnical, hydraulic and agronomic properties, and total metals analyses (parameters are listed in Table 3.2). Geochemical testing included paste pH, acid-base accounting (ABA) (consisting of sulfur species analyses, acid neutralization potential (ANP) and acid generation potential (AGP) analyses/calculations) and Meteoric Water Mobility Procedure (MWMP) testing for Nevada Profile II parameters. Total metals analyses included antimony, arsenic, copper, cadmium, lead, manganese, mercury, nickel, selenium, silver and zinc. Agronomic testing consisted of analysis for exchangeable metals, available plant nutrients, electrical conductivity and pH. In addition, geotechnical testing consisted of grain size analyses, and the hydraulic testing consisted of bulk density, porosity, saturated and unsaturated hydraulic conductivity and soil water retention properties. The laboratory reports for these analyses are included in Appendix B, *Analytical Laboratory Reports*; Appendix C, *Geotechnical Laboratory Reports*; and Appendix D, *Hydraulic Parameter Laboratory Reports*. Analytical data (agronomic data, geochemical data and total metals data) are summarized in Table B.1 (Appendix B), and geotechnical and hydraulic properties are summarized in Tables C.1 (Appendix C) and D.1 (Appendix D), respectively. Selected data are summarized and described in the following sections.

In addition, water samples were collected from the ROM draindown (sample RD-01) and crushed ore heap-leach pad draindown (sample CD-01). The draindown water samples were collected at the base of the pads (prior to flowing into the vegetated channels) and were analyzed for field parameters, Nevada Profile II parameters and total cyanide.

3.1.1 Crushed Ore Pad

The crushed ore heap-leach pad contains approximately 690,000 cubic yards of material and covers an area of approximately 11 acres. Material on the crushed ore heap-leach pad consists of ore crushed to a minus ¾-inch diameter. Few fines were present in the top three inches of the material, at the time of sampling. Three samples were collected from the top three to 24 inches of material and composited for analysis. The composite sample locations for sample LP-CO are shown on Figure 3-1.

Geotechnical analyses were conducted on the composite sample LP-CO to better define the type of materials within the crushed ore heap-leach pad. Sieve analysis of the material resulted in 25 percent of the material passing the #200 mesh, and Atterburg Limits testing results indicated a clayey matrix (liquid limit of 22 and plasticity index of 8). Based on these analyses, the material was characterized as a clayey-gravel (GC), according to the Unified Soil Classification System (USCS). Hydraulic parameters for the crushed ore heap-leach pad material (sample LP-CO) were also analyzed. Dry bulk density was reported as 1.30 g/cm^3 and porosity was 51 percent. Saturated hydraulic conductivity, as determined by the constant head method, was 5.9 x 10^{-2} cm/sec.

Geochemical properties, including ABA data, are summarized in Table 3.4, *Crushed Ore Heap-leach Pad Geochemical Results.* The primary factors influencing ABA chemistry are potential of sulfide-bearing materials to produce acid (AGP), offset by the neutralization capacity of the material (ANP).

TABLE 3.4 CRUSHED ORE HEAP-LEACH PAD GEOCHEMICAL RESULTS	
Parameter	**LP-CO Results**
Paste pH	7.5
Electrical Conductivity (mmhos/cm)	0.61
Total Sulfur (%)	0.26
Pyritic (sulfide)-sulfur (%)	0.02 B
Sulfate-Sulfur (%)	0.01 U
Acid Generation Potential (T/KT CaCO3)	1 E
Acid Neutralization Potential (T/KT CaCO3)	59
Net Neutralization Potential (T/KT CaCO3)	58 E
Neutralization Potential Ratio (ANP/AGP)	59 E

Notes:
U: Analyte not detected at the method detection limit (MDL). Value shown is the MDL.
B: Analyte detected above the MDL, but below the practical quantitation limit (PQL). Value shown is an estimate.
E: Calculation based on estimated concentration(s). Value is estimate.

The AGP of a material is calculated based on the pyritic (sulfide)-sulfur percentage, and the ANP is based on the neutralizing capacity of the material (both are expressed as carbonate equivalent). The Net Neutralization Potential (NNP) is defined as the difference between the ANP and AGP. A NNP less than 20 indicates that the material has significant potential for acid generation and a NNP greater than 20 indicates the material is not likely to produce acid. The Neutralization Potential Ratio (NPR) is the ratio of the ANP to the AGP. In general, a NPR less than three indicates potentially acid generating material and an NPR greater than three indicates excess acid neutralizing potential. While these general guidelines are used for mine planning and preliminary assessment purposes, site-specific conditions (e.g., water and oxygen availability or type of neutralization minerals present) often determines the actual acid-generating potential of a material. As shown in the table, the paste pH of sample LP-CO was circum-neutral at 7.5. Pyritic (sulfide)-sulfur content was low, resulting in a calculated AGP of approximately 1 T/KT $CaCO_3$. Measured ANP value was 59 T/KT $CaCO_3$. Therefore the NNP was approximately 58 and the NPR was approximately 59 indicating that this material has low potential to produce acidity and is likely to have neutralizing characteristics.

Agronomic data are summarized in Table 3.5, *Crushed Ore Heap-Leach Pad Agronomic Results* and the complete results are presented in Appendix B. These data indicate that the pH and electrical conductivity of the material is within the tolerable range for plant growth, although the material is somewhat limited in organic matter and nutrients.

TABLE 3.5 CRUSHED ORE HEAP-LEACH PAD AGRONOMIC RESULTS		
Parameter	**Recommended Range for Plant Growth**	**Result**
Paste pH	6.0 – 8.5	7.5
Electrical Conductivity (mmhos/cm)	< 4.0	0.61
Organic Matter (%)	> 1.0	0.19
Nitrogen, Ammonia (mg/kg)	na	20
Extractable Phosphorous (mg/kg)	na	4.3
Extractable Potassium (meq/100 g)	na	0.48
Sodium Adsorption Ratio (SAR)	< 6	3.89
Total Copper (mg/kg)	< 40	10
Total Manganese (mg/kg)	<60	142
Total Zinc (mg/kg)	<40	198

A MWMP analysis was not completed on the heap-leach pad materials due to the availability of water quality data from pad draindown. Water quality of draindown from the heap-leach pads is discussed in Section 3.1.3, *Heap-Leach Pad Draindown*.

3.1.2 Run-of-Mine Pad

The ROM pad contains approximately 609,000 cubic yards of material and covers approximately 10 acres. Samples were collected from the top three to 24 inches of the ROM pad in three locations and composited into one representative sample (LP-ROM). These locations are shown on Figure 3-1.

Geotechnical analyses were conducted on the composite sample LP-ROM to better define the type of materials within the ROM heap-leach pad. Based on the results of the sieve analysis (18 percent of the material was finer than #200 mesh) and Atterberg Limits test, the LP-ROM sample was classified as a clayey-gravel (GC) according to the USCS. Results of the geotechnical analyses are reported in Appendix B. Hydraulic parameters were measured on sample LP-ROM for the ROM heap-leach pad material. Dry bulk density and porosity were similar to the crushed ore pad material and were reported as 1.29 g/cm^3 and 51.5 percent, respectively. Saturated hydraulic conductivity was 9.6 x 10^{-2} cm/s. Methods and results of these analyses are presented in Appendix C.

Geochemical results are summarized in Table 3.6, *ROM Heap-leach Pad Geochemical Results*. The paste pH of the LP-ROM sample material was 7.1, and pyritic (sulfide)-sulfur was not detected. The ABA data indicates a relatively high ANP resulting in a NNP of approximately 64 T/KT CaCO3 and a NPR of approximately 65. These data indicate that there is little potential for the production of acidity from the ROM heap-leach pad materials.

TABLE 3.6
ROM HEAP-LEACH PAD GEOCHEMICAL RESULTS

Parameter	Result
Paste pH	7.1
Electrical Conductivity (mmhos/cm)	0.18
Total Sulfur (%)	0.61
Pyritic (sulfide)-sulfur (%)	0.01 U
Sulfate-Sulfur (%)	0.05 B
Acid Generation Potential (T/KT CaCO3)	1 E
Acid Neutralization Potential (T/KT CaCO3)	65
Net Neutralization Potential (T/KT CaCO3)	64 E
Neutralization Potential Ratio (ANP/AGP)	65 E

Notes:
U: Analyte not detected at the method detection limit (MDL). Value shown is the MDL.
B: Analyte detected above the MDL, but below the practical quantitation limit (PQL).Value shown is an estimate.
E: Calculation based on estimated concentration(s). Value is estimate.

The agronomic results for sample LP-ROM are summarized in Table 3.7, *ROM Heap-Leach Pad Agronomic Results*, and the complete results are presented in Appendix B. Similar to the crushed ore pad materials, these data indicate that the pH and electrical conductivity of the material is within the tolerable range for plant growth, although the material is somewhat limited in organic matter and nutrients.

TABLE 3.7
ROM HEAP-LEACH PAD AGRONOMIC RESULTS

Parameter	Recommended Range for Plant Growth	Result
PH	6.0 – 8.5	7.1
Electrical Conductivity (mmhos/cm)	< 4.0	0.18
Organic Matter (%)	> 1.0	0.15
Nitrogen, Ammonia (mg/kg)		29
Extractable Phosphorous (mg/kg)		3.1
Extractable Potassium (meq/100 g)		0.44
Sodium Adsorption Ratio (SAR)	< 6	1.08
Total Copper (mg/kg)	< 40	15
Total Manganese (mg/kg)	<60	753
Total Zinc (mg/kg)	<40	473

In general, ROM and crushed ore heap-leach pad materials display similar geochemical properties (i.e., neutral pH and low potential to generate acidity in the future), geotechnical characteristics (although the ROM has less fines and slightly higher permeability) and agronomic properties.

3.1.3 Heap-Leach Pad Draindown

Water samples were collected from the ROM draindown (sample RD-01) and crushed ore heap-leach pad draindown (sample CD-01). The draindown water samples were collected at the base of the pads (prior to flowing into the vegetated channels) and were analyzed for field parameters, Nevada Profile II parameters and total cyanide. It was assumed that the water quality of the draindown waters is representative of leachate from the pads, and therefore MWMP testing of the pad materials was not necessary. Sampling activities followed the procedures detailed in the Final Work Plan and Field Sampling Plan (FSP) (MWH, 2002). Flows were estimated at less than one gallon per minute (gpm) for both the ROM and crushed ore heap-leach draindown.

Water quality results for the draindown samples (RD-01 and CD-01) are reported in Table 3.3 with the State of Nevada Profile II Parameter Standards. These standards are generally equivalent to the U.S. Environmental Protection Agency (EPA) primary and secondary drinking water standards with the exception of antimony (the EPA primary drinking water standard for antimony is also presented in the table). In some of the water samples, the detection limit for berylium (0.005 mg/L) was slightly above the Nevada Profile II standard (0.004 mg/L); however these data are still considered useful for characterization purposes. Constituents in the draindown waters that exceed Nevada standards are highlighted in bold on the table and include antimony, arsenic, magnesium, selenium, thallium, nitrate+nitrite (as N), sulfate, total dissolved solids (TDS) and weak-acid dissociable (WAD) cyanide. WAD cyanide was above standards in the ROM draindown water sample, but did not exceed the standard (0.2 mg/L) in the crushed ore draindown water sample. Water quality analytical data reports are included in Appendix B.

The draindown waters were generally in the alkaline range; laboratory pH values for the ROM and crushed ore draindown waters were both 7.9. The TDS of the ROM and crushed ore draindown water samples were 5,530 and 8,300 mg/L, respectively. These high TDS values reflect the relatively high concentrations of major cations and anions in the draindown waters. Specifically, total sulfate concentrations in the samples were 3,050 and 4,680 mg/L, sodium concentrations were 1,240 and 1,700 mg/L, magnesium concentrations were 178 and 273 mg/L, and chloride concentrations were 118 and 198 mg/L, respectively.

Samples collected in May 2001 for the Remedial Action Scoping Report (MWH, 2001) report several constituents that exceeded the Nevada standards. Antimony, arsenic, mercury, selenium, thallium, nitrate+nitrite (as N), cyanide, fluoride, sulfate and TDS exceeded standards in one or both draindown water samples. Neither mercury nor fluoride exceeded Nevada standards during the 2002 sampling event. A summary of results from the 2001 sampling event are presented on Tables E-1 and E-2, located in Appendix E, *Historic Water Quality Analytical Data*.

Alta Gold reported water quality data from quarterly sampling between 1996 and 1998 in their request for Approval of Land Application of Heap Rinsate/Drain-Down Solution (Alta Gold, 1998). Quarterly data from 1999 was also reported in the Leachfield Design Report (Alta Gold, 2000). Data from the crushed ore and ROM draindown water samples are presented in Tables E-1 and E-2 (Appendix E). Constituents exceeding standards were the same as those reported in the current sample rounds with the addition of cadmium. There does not appear to be significant trends in the constituent concentrations over time. However, an exception is cyanide concentrations that have exhibited a general decrease since the cessation of the rinsing activities.

3.2 PROCESS PONDS

Following is a discussion of the current condition of the three process ponds, including a discussion of the evaluation of pond overflow potential. Results of the process pond sampling activity is also discussed.

3.2.1 Process Pond Description and Overflow Evaluation

The pregnant solution ponds and the barren pond were constructed and sized to contain a 48-hour draindown from the pads as well as handle a 100-year, 24-hour storm event. The ponds are cut and fill structures with approximately 80 percent being built in cut. The fill portions were built in 12-inch lifts and compacted to 95 percent of optimum density. Sideslopes of the ponds are 3(H):1(V). Pond bottoms were graded to direct potential seepage toward a leak detection system. A 12-inch layer of clayey material was placed over the sides and bottom and compacted, forming the secondary liner. The primary liner consists of 60-mil HDPE material with thermally welded seams. The leak detection system was installed between the primary HDPE liner and the secondary clay liner. These ponds were permitted to operate as a zero-discharge facility under Water Quality Control Permit #NEV89023. According to the April 21, 1998 application for a Water Pollution Control Permit, the ROM and crushed ore ponds each have a 3.25-million gallon capacity. The barren pond has a 1.5 million gallon capacity (MWH, 2001).

Over the last two years, water levels have been falling more rapidly in the ROM pond then the crushed ore pond. During the Site visit on 25 June 2002, a hole was discovered in the southwest corner of the ROM pond. The liner had been perforated in three small areas that appeared to have been patched earlier. During the June Site visit, very little flow was draining from the ROM heap-leach pad (not measurable), and this small amount of flow was being lost to evaporation and vegetation uptake prior to reaching the pond. During the November sampling event, the barren pond was essentially dry (no water), and the crushed ore and ROM pregnant ponds contained approximately two to three feet of water (visual estimate of water depth).

An analysis was performed to evaluate the potential for pond overflow. This task involved a conservative calculation of the pond overflow potential based on pond capacities and expected draindown from the heap-leach pads. Data used for this calculation included BLM monitoring information, pond storage and capacity data, and climatic data. Simple analytical equations comparing pond capacities to potential draindown, precipitation and evaporation rates were used to determine the potential for pond overflow. These evaluations concluded that the ponds would be able to store typical annual precipitation amounts, but the conservative water balance indicated that overflow could occur during an above-normal precipitation year. This assessment is presented in Appendix F, *Pond Overflow Evaluation.*

3.2.2 Process Pond Sampling

One representative water quality sample was collected from the ROM pregnant pond (sample ROM-01), the crushed ore pregnant pond (sample CO-01) and the barren pond (sample BP-01) and analyzed for field parameters, Nevada Profile II parameters and total cyanide. Pond water levels were also obtained. The fluid levels in the ponds at the time of sample collection were approximately 2.5 feet, 2.0 feet and 0.3 feet for the ROM, crushed ore and barren pond, respectively. The analytical data are presented in Table 3.3. The results of all process pond analyses are located in Appendix D.

Process pond water quality exhibited similar concentrations as the draindown water data. The same constituents that exceeded Nevada standards in the draindown waters, also were exceeded in the ponds with the addition of cadmium, silver, iron, chloride and pH. However, cadmium and iron were only detected in the crushed ore pond sample at a concentration below the practical quantitation limit (PQL). WAD cyanide was above standards in the ROM and barren ponds, but did not exceed standards in the crushed ore pond.

The TDS of the three ponds ranged from 21,300 to 43,800 mg/L, with the highest concentration in the barren pond. These high TDS values reflect the relatively high concentrations of major cations and anions in the pond waters. Specifically, total sulfate concentrations in the ponds range from 12,700 to 20,800 mg/L, chloride concentrations range from 600 to 2,200 mg/L and sodium concentrations range from 5,630 to 9,370 mg/L. The pond waters were all in the alkaline range; laboratory pH values for the ROM, crushed ore and barren ponds were 9.0, 8.9 and 8.8, respectively. Major ion concentrations in the process ponds were higher than in the draindown water samples, likely due to evapoconcentration of these constituents in the process ponds.

Samples collected in May 2001 (MWH, 2001) show similar results as those described above. Historic data from the process ponds are presented on Table E.3 (Appendix E).

3.3 WASTE ROCK PILE

The waste rock pile covers approximately 66 acres and is located to the west of the mine pit. Previous reclamation activities performed on the waste rock pile included re-contouring and seeding. Mapping performed in 2002 indicated vegetation had established on approximately 55 acres (83 percent) of the pile. Waste rock characterization included mapping of barren areas (i.e., poor vegetation), soil sampling from both vegetated and barren areas and paste pH mapping. Vegetation mapping and paste pH test locations are presented on Figure 3-2, *Waste Rock pH Survey*.

Two composite samples, consisting of three sampling locations each, were collected from the vegetated and barren areas, respectively. The barren waste rock material (WRB) and vegetated waste rock material (WRV) composite sample locations are shown on Figures 3-1 and 3-2. These composite samples were analyzed for geochemical and agronomic properties and total metals, as listed in Table 3.2. The laboratory reports for these analyses are included in Appendix B, and analytical data (agronomic data, geochemical data and total metals data) are summarized in Table B.1 (Appendix B). Selected data are summarized and described in the following sections. A screening-level risk assessment of the metals concentrations of the barren area materials is also discussed in Section 3.3.2.

3.3.1 Material Properties

Waste rock pile material was observed to consist of sandy or gravelly silts in vegetated areas and clayey silt in areas of poor vegetation. Vegetated areas exist on either old oxide pit material or on areas that were covered with borrow material/old topsoil from the original reclamation effort. Barren areas generally exist on black pyritic material from the mine pit overburden. The composite sample from the barren areas had distinctly different geochemical characteristics compared to the vegetated areas composite sample. Table 3.8, *Waste Rock Geochemical Results*, summarizes selected waste rock geochemical data.

TABLE 3.8
WASTE ROCK GEOCHEMICAL RESULTS

Parameter	Barren Area Sample (WRB)	Vegetated Area Sample (WRV)
Paste pH	2.1	6.7
Electrical Conductivity (mmhos/cm)	8.59	1.59
Total Sulfur (%)	1.83	0.26
Pyritic (Sulfide)-Sulfur (%)	0.35	0.05 B
Sulfate-Sulfur (%)	1.08	0.11
Acid Generation Potential (AGP) (T/KT CaCO3)	11	2 E
Acid Neutralization Potential (ANP) (T/KT CaCO3)	1 U	56
Net Neutralization Potential (NNP) (T/KT CaCO3)	-10 E	54 E
Neutralization Potential Ratio (NPR) (%)	0.09 E	28 E

Notes:
The NNP is defined as the difference between the ANP and the AGP (ANP – AGP).
Then NPR is the ratio of the ANP and the AGP (ANP/AGP).
U: Analyte not detected at the method detection limit (MDL). Value shown is the MDL.
B: Analyte detected above the MDL, but below the practical quantitation limit (PQL). Value shown is an estimate.
E: Calculation based on estimated concentration(s). Value is estimate.

Geochemical conditions between the barren and vegetated areas differed both in terms of paste pH (current acidity) and ABA (potential to produce future acidity) values. The ABA data for the waste rock samples indicate that material from barren areas has excess acid generating potential while the vegetated areas have a net neutralizing potential. The barren area sample (WRB) had a pH value of 2.1 compared to a pH of 6.7 in the vegetated area sample (WRV). The composite sample from the barren area had a pyritic (sulfide)-sulfur value of 0.35 percent, resulting in an AGP of 11 T/KT $CaCO_3$ and an absence of neutralizing potential (ANP below the detection limit). Therefore the NNP for this material is approximately –10 T/KT $CaCO_3$ and the NPR is approximately 0.09, indicating that the material has the potential to generate further acidity. The sample from the vegetated areas reported approximately 0.05 percent pyritic (sulfide)-sulfur, resulting in an AGP of 2 T/KT $CaCO_3$ (estimated), with an ANP of 56 T/KT $CaCO_3$. Therefore, the NNP for the material is approximately 54 T/KT $CaCO_3$ and the NPR is approximately 28, indicating that this sample is not likely to generate acid in the future. Based on these data, it appears that surface materials in barren areas are acid generating and have the potential to produce additional acid in the future, while materials from vegetated areas are not acid generating and are not likely to produce additional acid in the future.

The two waste rock composite samples (WRV and WRB) were tested using the Nevada MWMP to evaluate the potential for dissolution and mobility of constituents from the waste rock pile materials. Leachate from the MWMP test was analyzed for the Nevada Profile II Parameters. Analytical data and Nevada standards are presented in Table 3.9, *Waste Rock MWMP Leachate Analyses.*

Leachate from the barren sample had a pH of 2.3, TDS of 25,800 mg/L (reflecting the high sulfate concentration of 19,400 mg/L) and the alkalinity was below the detection limit of 2 mg/L. Leachate from the vegetated sample had a pH of 7.0, TDS of 2,440 mg/L and alkalinity of 99 mg/L as $CaCO_3$. These pH, TDS and alkalinity values from the MWMP analyses support the paste pH and ABA data.

TABLE 3.9 WASTE ROCK MWMP LEACHATE ANALYSES GOLDEN BUTTE CLOSURE PLAN				
ANALYTE	UNITS	Nevada Profile II Standards	Analytical Data	
			061102-WRV	061102-WRB
			11/06/02	11/06/02
Aluminum (MWMP)	mg/L	0.05 - 0.2	0.06 U	1320
Antimony (MWMP)	mg/L	0.146 (0.006 EPA)	0.041	0.1 U
Arsenic (MWMP)	mg/L	0.05	0.003 U	19.7
Barium (MWM)	mg/L	2.0	0.034	0.06 U
Beryllium (MWMP)	mg/L	0.004	0.0005 U	0.11
Bismuth (MWMP)	mg/L	ns	0.1 U	2 U
Boron (MWMP)	mg/L	ns	0.34	0.2 B
Cadmium (MWMP)	mg/L	0.005	0.005 U	0.8
Calcium (MWMP)	mg/L	ns	399	530
Chromium (MWMP)	mg/L	0.1	0.01 U	3.2
Cobalt (MWMP)	mg/L	ns	0.01 U	8.4
Copper (MWMP)	mg/L	1.3	0.02 U	6.7
Gallium (MWMP)	mg/L	ns	0.1 U	2 U
Iron (MWMP)	mg/L	0.3 - 0.6	0.12	3630
Lead (MWMP)	mg/L	0.015	0.0005 U	0.02 U
Lithium (MWMP)	mg/L	ns	0.04 B	0.7 B
Magnesium (MWMP)	mg/L	125 - 150	138	409
Manganese (MWMP)	mg/L	0.05 - 0.10	0.34	34
Mercury (MWMP)	mg/L	0.002	0.0002 U	0.0002 U
Molybdenum (MWMP)	mg/L	ns	0.01 U	0.2 U
Nickel (MWMP)	mg/L	0.1	0.03 B	30.9
Potassium (MWMP)	mg/L	ns	35.5	6 U
Scandium (MWMP)	mg/L	ns	0.1 U	4 B
Selenium (MWMP)	mg/L	0.05	0.041	0.19
Silver (MWMP)	mg/L	0.1	0.005 U	0.001 U
Sodium (MWMP)	mg/L	ns	42.7	6 U
Strontium (MWMP)	mg/L	ns	0.56	0.2 U
Thallium (MWMP)	mg/L	0.002	0.0062	0.001 U
Tin (MWMP)	mg/L	ns	0.2 U	2 U
Titanium (MWMP)	mg/L	ns	0.01 U	0.3 U
Vanadium (MWMP)	mg/L	ns	0.01 U	0.4 B
Zinc (MWMP)	mg/L	5.0	0.02 U	28.7
pH (MWMP)	units	6.5 - 8.5	7.0	2.3
Total Alkalinity (MWMP)	mg/L	ns	99	2 U
Bicarbonate as CaCO3	mg/L	ns	99	2 U
Carbonate as CaCO3	mg/L	--	2 U	2 U

TABLE 3.9
WASTE ROCK MWMP LEACHATE ANALYSES
GOLDEN BUTTE CLOSURE PLAN

ANALYTE	UNITS	Nevada Profile II Standards	Analytical Data	
			061102-WRV	061102-WRB
			11/06/02	11/06/02
Hydroxide as CaCO3	mg/L	--	2 U	2 U
Chloride (MWMP)	mg/L	250 - 400	5	4 B
Cyanide, WAD (MWMP)	mg/L	0.2	0.01 U	0.01 U
Fluoride (MWMP)	mg/L	2.0 - 4.0	0.7	40 B
Nitrate/Nitrite as N (MWMP)	mg/L	10	6.3	0.77
Phosphorus, total (MWMP)	mg/L	ns	0.1 B	174
Sulfate (MWMP)	mg/L	250 - 500	1640	19400
TDS (MWMP)	mg/L	500 - 1000	2440	25800

Notes: MWMP - Meteoric Water Mobility Procedure
WRV - Waste Rock Vegetated
WRB - Waste Rock Barren
Shaded values exceed Nevada Profile II standard
U: Analyte not detected above the method detection limit (MDL). Value shown is the MDL.
B: Analyte detected above the MDL and below the practical quantitation limit (PQL). Value shown is estimated

Several constituents (shown in bold on Table 3.9) exceeded standards in the MWMP leachate from the barren area soil sample (WRB). The exceedencess included aluminum, antimony, arsenic, beryllium, cadmium, chromium, copper, iron, manganese, nickel, selenium, zinc, fluoride, magnesium, sulfate, TDS and pH. In the vegetated area soil sample (WRV) leachate, Nevada standards were exceeded for antimony, manganese, thallium, sulfate and TDS; however, the exceedences of manganese, sulfate and TDS from the vegetated sample were to a lesser degree than from the barren sample.

Agronomic data were collected from waste rock samples to evaluate their potential as a growth medium. The agronomic results from the waste rock samples are summarized in Table B.1 (Appendix B) and selected data are shown in Table 3.10, *Waste Rock Agronomic Results*. The agronomic analyses for the waste rock areas confirm observations made in the field, specifically, that the barren areas were impacted by acid generation from the waste rock. The paste pH value for the barren waste rock is depressed below the desirable range and the high electrical conductivity indicates that salt concentrations are elevated. These data suggest that vegetative growth in the barren areas is limited by low pH and high salt content. While some of the metals in the composite sample from the vegetated area exceed the recommended ranges, the grasses growing on the waste rock appear to be tolerant of these levels.

TABLE 3.10
WASTE ROCK AGRONOMIC RESULTS

Parameter	Recommended Range for Plant Growth	Barren Area Sample (WRB)	Vegetated Area Sample (WRV)
Paste pH (std. Units)	6.0 – 8.5	2.1	6.7
Electrical Conductivity (mmhos/cm)	< 4.0	8.59	1.59
Organic Matter (%)	> 1.0	1.75	0.97
Nitrogen, Ammonia (mg/kg)		23	25
Extractable Phosphorous (mg/kg)		22.1	1.4
Extractable Potassium (meq/100 g)		0.2 U	0.73
Sodium Adsorption Ratio (SAR)	< 6	0.05 B	0.46
Total Copper (mg/kg)	< 40	19	20
Total Manganese (mg/kg)	<60	47.3	150
Total Zinc (mg/kg)	<40	55	106

Notes:
U: Analyte not detected at the method detection limit (MDL). Value shown is the MDL.
B: Analyte detected above the MDL, but below the practical quantitation limit (PQL). Value shown is an estimate.

3.3.2 Screening-Level Risk Assessment of Metals Concentrations

The total metals concentrations in the waste rock soil samples (WRV and WRB) are presented on Table 3.11, *Benchmark Risk Management Criteria for Metals in Soils*, with background soil concentrations, as represented by the borrow source soil samples (BS-01, BS-02 and BS-03). As described in more detail in Section 3.5, Borrow Sources, it is arguable that borrow source BS-02 is not representative of background conditions, as this sample was collected from the near-surface soils on the crusher pad. However, borrow source BS-01 was collected from the silt pit to the west and borrow source BS-03 was collected from the colluvial materials on-site. Therefore, these samples may be considered as representative of background concentrations. Metals concentrations for these soils are compared to risk management criteria (RMCs) developed by BLM as screening criteria for human health and wildlife risk associated with metals on BLM sites (Ford, 1996). The human health RMC for the worker scenario was deemed most appropriate for this evaluation, due to the remote location of the Site. The benchmark wildlife RMC was developed by calculating the 95 percent lower confidence limit on the mean (LCLM) of all of the wildlife criteria (as per Ford, 1996)

TABLE 3.11
BENCHMARK RISK MANAGEMENT CRITERIA FOR METALS IN SOILS
GOLDEN BUTTE CLOSURE PLAN

Sample Identification	Date	pH (s.u.)	Antimony, total	Arsenic, total	Cadmium, total	Copper, total	Lead, total	Manganese, total	Mercury, total	Nickel, total	Selenium, total	Silver, total	Zinc, total
Human Risk Management Criteria for Soils (Ford, 1996)													
	Resident	nd	3	1	3	250	400	960	2	135	35	35	2,000
	Camper	nd	50	20	70	5,000	1,000	19,000	40	2,700	700	700	40,000
	Worker[1]	nd	100	265[2]	100	7,400	2,000	28,000	60	4,000	1,000	1,000	60,000
	Surveyor	nd	600	100	800	59,000	2,000	220,000	480	32,000	8,000	8,000	480,000
	ATV Driver	nd	750	300	950	70,000	1,000	250,000	550	38,000	9,600	9,600	550,000
Wildlife and Livestock Risk Management Criteria for Soils[3] (Ford, 1996)													
	Minimum	nd	nd	4	0.3	7	6	nd	1	nd	nd	nd	43
	Maximum	nd	nd	438	15	640	244	nd	45	nd	nd	nd	1082
	95% LCLM	nd	nd	159	3	101	77	nd	5	nd	nd	nd	221
Golden Butte Soil Samples													
061102-WRV	11/06/02	6.7	32	134	1.11	20	19.9	150	3.18	37	4	0.5 U	106
061102-WRB	11/06/02	2.1	91	**250**	1.2	19	17.6	47.3	4.54	48	2.8 B	1 U	55
071102-BS-01	11/07/02	7.8	8.3	20.1	0.75	11	12.2	371	0.05 U	10	0.8 U	0.07 B	83
071102-BS-02	11/07/02	7.6	**360**	**175**	0.7 B	14	19.6	271	**14**	21	8 U	3 U	78
071102-BS-03	11/07/02	8.4	52	100	0.6 B	14	11.5	314	1.31	20	4 U	0.5 U	64

Notes:
Ford, Karl L., Ph.D. 1996. Risk Management Criteria for Metals at BLM Mining Sites. Bureau of Land Management, National Applied Resource Sciences Center. Denver, CO. Technical Note 390 (revised). December 1996. BLM/RS/ST-97/001+1703.
The most appropriate exposure scenarios/criteria are highlighted
1. The worker scenario was deemed most appropriate for the Golden Butte Site.
2. The human health risk criteria for arsenic was adjusted for site specific analysis , as discussed in section 3.3.2.
3. Wildlife/Livestock include deer mouse, cottontail, bighorn sheep, white-tailed deer, mule deer, elk, cattle, sheep, mallard, canada goose, trumpeter swan, and robin. The 95% lower confidence limit of the mean (95% LCLM) is presented.

Shaded cells exceed either Human Risk Management Criteria for workers and/or the wildlife criteria.
WRV: WASTE ROCK, VEGETATED
BORROW SOURCES:
WRB: WASTE ROCK, BARREN
BS-01: Silt Pit near West Well
BS-02: Crusher Pad
BS-03: Near Administration area

Based on this comparison, the waste rock barren soil contains arsenic levels above the human health and wildlife RMCs. Several other sources of soil criteria for protection of human health and wildlife were also used to evaluate the soils data. These criteria are presented on Table B.2 of Appendix B.

The human health RMC for arsenic was evaluated in more detail. The RMCs developed by BLM were designed to protect human receptors for the metals of concern using available toxicity data and standard EPA exposure assumptions. CERCLA regulations (40 CFR 300) require regulation on the basis of excess risk at a lifetime rate of 10^{-6} to 10^{-4}.

Thus, the arsenic soil RMC needs to be applied to the incremental concentration above the background soil concentration. From the limited background data available, it appears that the naturally occurring arsenic concentration in soils, as represented by BS-01 and BS-03, is approximately 20 to 100 mg/L, which is higher than what is usually observed in other areas of the United States. Higher-than-typical background is normal at mine sites due to the mineralized nature of the surroundings. By federal regulation (40 CFR 300) an acceptable incremental cancer rate can be as high as 10^{-4} and EPA policy is to target cleanups at this level unless good reason exists to go lower (as low as 10^{-6}). Given that Golden Butte Mine is quite isolated, the number of people exposed and the degree of exposure to such people are both expected to be very low; therefore, a rate of 10^{-4} seems prudent. This adjustment increases the arsenic criteria to 265 mg/kg. The arsenic concentrations in the waste rock barren (WRB) and waste rock vegetated (WRV) samples are 250 and 134 mg/kg, respectively. These concentrations are below the adjusted arsenic criteria of 265 mg/kg, and the incremental arsenic concentrations above background are all well below this value. Therefore, from a human health perspective the data indicate no imminent and substantial endangerment to human health.

Similarly, because arsenic is the only metal that indicates potential risk to wildlife, and because the arsenic concentration in the barren soils (250 mg/L) is within the same order of magnitude as the wildlife criteria (159 mg/L), it may be argued that the risk to wildlife due to metals concentrations in the barren soils is not substantial.

The low pH of the soils was not directly evaluated with respect to risk. However, it is apparent based on agronomic standards as well as empirical evidence that vegetation will not be established in these soils.

3.3.3 Waste Rock Pile Mapping and Paste pH Sampling

Vegetated and non-vegetated (barren) areas were mapped in the field using a field global positioning system (GPS) unit. The outlines of these areas are presented on Figure 3-2. As shown on this figure, a total of approximately 11 acres of the waste rock pile are barren and approximately 55 acres are vegetated. Of the 11 acres of barren soil, it is estimated that nine acres are without vegetation due to acidic soils, while the other two acres are limited due to lack of fine materials (also shown on Figure 3-2). Paste pH sampling of the waste rock pile was performed to provide an indication of readily available acidity in the surficial materials. Sampling was performed as described in the Final Work Plan (MWH, 2002) according to the methodology presented in the FSP. Paste pH sample locations and results are presented on Figure 3-2 and listed in Table 3.12, *Waste Rock Paste pH Sample Results*. Paste pH measurements were performed in both vegetated and barren areas of the pile. Results indicate that the majority of non-vegetated areas have acid-producing soils. The pH values in non-vegetated areas had a geometric mean of 2.7, indicating acidic conditions. However, within the non-vegetated regions, there were isolated locations with pH values ranging from 5.0 to 6.0. The pH of soils in vegetated areas was generally above 6.0 (geometric mean of 6.0).

TABLE 3.12 WASTE ROCK PASTE pH SAMPLE RESULTS GOLDEN BUTTE CLOSURE PLAN		
SAMPLE NO.	**PASTE pH (su)**	**SAMPLE DESCRIPTION**
Non-Vegetated Areas		
1	3.2	Non-vegetated, acidic
2	7.1	Non-vegetated, non-acidic
3	3.2	Non-vegetated, acidic
5	3.5	Non-vegetated, acidic
7	3.5	Non-vegetated, acidic
9	6.6	Non-vegetated, non-acidic
11	1.9	Non-vegetated, acidic
12	2.5	Non-vegetated, acidic
14	6.5	Non-vegetated, non-acidic
15	6.6	Non-vegetated, non-acidic
18	4.8	Non-vegetated, acidic
19	2.0	Non-vegetated, acidic
20	1.9	Non-vegetated, acidic
22	1.9	Non-vegetated, acidic
23	3.3	Non-vegetated, acidic
24	5.5	Non-vegetated, acidic
25	6.1	Non-vegetated, non-acidic
26	9.4	Non-vegetated, non-acidic
27	3.9	Non-vegetated, acidic
28	1.8	Non-vegetated, acidic
29	1.9	Non-vegetated, acidic
30	4.5	Non-vegetated, acidic
32	2.1	Non-vegetated, acidic
34	3.4	Non-vegetated, acidic
35	5.3	Non-vegetated, acidic
36	1.9	Non-vegetated, acidic
38	6.2	Non-vegetated, non-acidic
39	6.7	Non-vegetated, non-acidic
40	2.9	Non-vegetated, acidic
41	1.7	Non-vegetated, acidic
42	1.8	Non-vegetated, acidic
43	2.4	Non-vegetated, acidic
45	1.6	Non-vegetated, acidic
46	1.5	Non-vegetated, acidic
47	1.7	Non-vegetated, acidic
48	1.5	Non-vegetated, acidic
49	1.4	Non-vegetated, acidic
50	0.7	Non-vegetated, acidic
51	comb 51/51	Non-vegetated, acidic
52	1.6	Non-vegetated, acidic
54	1.7	Non-vegetated, acidic
55	2.1	Non-vegetated, acidic
56	comb 56/57	Non-vegetated, acidic
57	2.3	Non-vegetated, acidic
58	1.3	Non-vegetated, acidic
59	2.1	Non-vegetated, acidic
61	2.5	Non-vegetated, acidic
62	1.2	Non-vegetated, acidic
Geometric Mean	**2.7**	
25th Percentile	**1.8**	
50th Percentile	**2.3**	
75 Percentile	**4.3**	
Vegetated Areas		

TABLE 3.12 WASTE ROCK PASTE pH SAMPLE RESULTS GOLDEN BUTTE CLOSURE PLAN		
SAMPLE NO.	**PASTE pH (su)**	**SAMPLE DESCRIPTION**
4	6.1	Vegetated, non-acidic
6	6.4	Vegetated, non-acidic
8	6.1	Vegetated, non-acidic
10	7.2	Vegetated, non-acidic
13	5.9	Vegetated, non-acidic
16	7.3	Vegetated, non-acidic
17	7.3	Vegetated, non-acidic
21	6.0	Vegetated, non-acidic
31	6.5	Vegetated, non-acidic
33	6.2	Vegetated, non-acidic
37	6.4	Vegetated, non-acidic
44	6.3	Vegetated, non-acidic
53	2.8	Vegetated, acidic
60	5.7	Vegetated, acidic
Geometric Mean	**6.0**	
25th Percentile	**6.1**	
50th Percentile	**6.3**	
75 Percentile	**6.5**	

3.4 GROUNDWATER

One groundwater sample was collected from the East Water Well (sample EW-01) and analyzed for field parameters, Nevada Profile II parameters and total cyanide. All activities followed the procedures detailed in the Final Work Plan and FSP (MWH, 2002). The water level at the time of sample collection was 41.6 feet below top of casing. The well was purged by pumping prior to sampling. Laboratory analyses are presented on Table 3.3 and laboratory reports are in Appendix B. The laboratory pH of the groundwater sample was 7.9. Total alkalinity (bicarbonate) was 240 mg/L as $CaCO_3$ and the TDS of the sample was 420 mg/L. Calcium (64.7 mg/L) and bicarbonate are the dominant cations/anions in the sample; therefore, this water is classified as a calcium/magnesium-bicarbonate type water, which is typical of groundwater from a carbonate bedrock aquifer. All constituents in groundwater were less than the Nevada Profile II standards. However, the EPA Primary Drinking Water Standard for antimony was exceeded in the groundwater sample. The antimony concentration was 0.016 mg/L compared to the EPA standard of 0.006 mg/L. These results appear to be representative of background groundwater conditions at the Site.

3.5 BORROW SOURCE INVESTIGATION

A soil cover with good water holding characteristics will be needed to cover the heap-leach pads to reduce infiltration into the material. With limited topsoil available at the Site, borrow soil will be needed to supplement existing topsoil for reclamation of the heap-leach pads (and possibly the waste rock disposal area).

3.5.1 Borrow Source Determination

Soil maps and descriptions from the BLM were used to facilitate the borrow source investigation. Potential borrow areas were investigated and sampled during site characterization. Samples were collected from three locations and were analyzed for agronomic properties and total metals concentrations (Table B.1, Appendix B), geotechnical properties (Table C.1, Appendix C) and hydraulic parameters (Table D.1, Appendix D).

Borrow samples were taken from: (1) the reclaimed borrow area near the West Water Well (BS-01), (2) the crusher pad (BS-02), and (3) the area below the East Water Well where the administration facilities were previously located (BS-03). Backhoe test pits were excavated to depths of approximately four to six feet to determine the available volume and suitability of soil for revegetation. One representative composite sample was analyzed from each potential source. Sample locations are shown on Figure 3-3, *Borrow Source Locations.*

3.5.2 Borrow Source Properties

Borrow sample BS-01 was obtained from the reclaimed borrow area (silt pit) southwest of the Site near the West Water Well. Silt material from this pit was used by Alta Gold for lining the heap-leach pads and ponds. Three test pits were excavated in the area and a composite sample was prepared using material from all three locations. The pits were approximately three feet wide and 15 feet long, with depths ranging from four to 6.4 feet. Geotechnical test results indicated that the material was non-plastic and was classified as a silty gravel (GM) using the Unified Soil Classification System (USCS). Geotechnical test results indicate that the material does not contain a significant clay fraction and may not be suitable as a cover soil.

Samples BS-02 and BS-03 were collected from test pits excavated in the crusher pad and near the East Water Well, respectively. Borrow area sample BS-03 is typical of the colluvium present at the Site. Both samples were characterized as clayey-gravels (GC) according to the USCS, with plasticity indices of 12 for the BS-02 material and 9 for the BS-03 material. The plasticity index indicates that there is clay in each material indicating that soil from either location will hold some water and may be suitable for cover construction. Geotechnical test results for all three borrow source samples are summarized on Table C.1 and reported in Appendix C.

Borrow soils were evaluated for erosional potential using the Revised Universal Soil Loss Equation (RUSLE) model. The model is used to calculate average annual erosion based on the rainfall factor (R), the soil erodibility factor (K), slope length factor (LS), the cover management factor (C) and the contour management factor (P). For this analysis the R, LS, C and P-factors were kept constant for each soil. A slope length of approximately 220 feet was used, representative of the leach pads regraded to a 3:1 slope. The cover management factor was calculated assuming that the long-term vegetation will approximate surrounding, undisturbed areas. The erodibility factor is based primarily on the percentages of silt and fine sand, clay and organic matter. The percentages of silt and fine sand were similar for all three borrow soils and ranged from approximately 45 to 55 percent. The percentages of clay were also similar for all three samples, and ranged from approximately 5 to 8 percent. BS-01 was classified as non-plastic, however it had a higher percentage of organic matter than either BS-02 or BS-03, making it similar in terms of erodibility. K-factors were calculated for each soil and ranged from approximately 0.31 to approximately 0.37, resulting in a calculated average annual soil loss of approximately 0.5 tons per acre per year. Based on this evaluation, any of the borrow sources would be suitable for cover.

The three samples report similar hydraulic properties as summarized in Table 3.13, *Borrow Source Material Properties*, and presented in Appendix D. Agronomic test reports are contained in Appendix B and results are summarized in Table B.1 (Appendix B). Selected agronomic data are summarized in Table 3.13. These data indicate that the pH and electrical conductivity of the materials are all within the tolerable range for plant growth, although the material is somewhat limited in organic matter. Additionally, there is available nitrogen, phosphorous and potassium in the soils to promote plant growth. Some metals concentrations are elevated above ideal ranges; however, this situation does not necessarily limit plant growth in the area (as shown empirically from the data for the vegetated sample on the waste rock pile).

TABLE 3.13 BORROW SOURCE MATERIAL PROPERTIES				
Parameter	Results			
	Recommended Range for Plant Growth	BS-01	BS-02	BS-03
GEOTECHNICAL DATA				
Porosity		50.7	51.2	51.0
Bulk density (g/cm3)		1.31	1.29	1.30
Saturated hydraulic conductivity (cm/sec)		1.2×10^{-4}	6.2×10^{-4}	2.5×10^{-4}
AGRONOMIC PARAMETERS				
PH	6.0 – 8.5	Not measured	7.6	8.4
Electrical Conductivity (mmhos/cm)	< 4.0	2.47	2.13	0.300
Organic Matter (%)	> 1.0	1.09	0.56	0.38
Nitrogen, Ammonia (mg/kg)	na	12	16	13
Extractable Phosphorous (mg/kg)	na	12	2.9	2.9
Extractable Potassium (meq/100 g)	na	3.05	1.42	2
Sodium Adsorption Ratio (SAR)	< 6	5.57	3.21	2.6
Total Copper (mg/kg)	< 40	11	14	14
Total Manganese (mg/kg)	< 60	371	271	314
Total Zinc (mg/kg)	< 40	83	78	64

3.5.3 Material Volume Estimation

As shown on Figure 3-3, the extent of the reclaimed borrow area (BS-01) is fairly large, and based on data obtained from the test pits the volume of soil available at the location is essentially unlimited. Material from the area was used to construct the foundations of the crushed ore and ROM heap-leach pads. During reclamation of the borrow source, a pit feature was left in place in the center of the area. The test trench excavated in the bottom of the pit revealed a sandy, cobbly soil that would likely be unsuitable for placement as a cover. However, around the perimeter of the pit the material was predominantly a silty material.

It was estimated that the crusher pad, borrow sample BS-02, contains approximately 13,000 yards of material. The volume was estimated based on a pile thickness of approximately 25 feet at the toe tapering to zero where the pile contacts the existing ground surface. The overall dimensions of the top of the pile were measured to be approximately 150 feet by 190 feet.

Borrow area BS-03, below the East Water Well, is a level pad where administration facilities were located prior to reclamation. Based on an average thickness of 12 feet and average dimensions of 100 feet by 135 feet, the volume of the pad was estimated to be approximately 2,000 cubic yards of material. This material is the colluvial material that is generally found all over the Site. There is likely an unlimited supply of this material, although collection of the material for borrow source requirements would require quarrying.

3.5.4 SUMMARY OF SITE CHARACTERIZATION

Field sampling and analysis of soil, water and mine materials was performed in November 2002 to support site characterization for development of this Closure Plan. Soil and mine material samples were collected from potential borrow areas, heap-leach pads and the waste rock pile. Water samples were collected from the crushed ore and ROM pad draindowns, three facility ponds and the East Water Well. The following information has been obtained based on this work:

Heap-Leach Pads and Draindown Waters

- Heap-leach pad materials are generally non-acidic and have low acid-generating potential.

- Parameters that exceeded Nevada Profile II Standards in draindown waters included antimony, arsenic, magnesium, selenium, thallium, nitrate+nitrite (as N), sulfate, TDS and WAD cyanide.

Process Ponds

- Parameters that exceeded Nevada Profile II Standards in pond water included antimony, arsenic, magnesium, selenium, thallium, nitrate+nitrite (as N), sulfate, TDS and WAD cyanide, cadmium, silver, iron, chloride and pH.

- Pond waters are alkaline and contain high TDS (major cations/anions).

Waste Rock Pile

- Barren areas on the waste rock pile are generally acidic and have the potential to generate additional acidity; low pH and high salt concentrations inhibit vegetation in barren areas.

- MWMP results for barren areas on waste rock exceed standards for aluminum, antimony, arsenic, beryllium, cadmium, chromium, copper, iron, manganese, nickel, selenium, zinc, fluoride, magnesium, sulfate, TDS and pH.

- Vegetated areas on the waste rock pile are non-acidic and have low acid-generating potential.

- MWMP results for vegetated areas on waste rock exceed standards for antimony, manganese, thallium, sulfate and TDS.

Groundwater

- Groundwater is an alkaline, calcium/magnesium-bicarbonate type water.

- Antimony was the only parameter that exceeded Nevada Drinking Water Standards in groundwater.

Borrow Source Investigation

- Borrow source BS-01 was classified as a silty-gravel with a hydraulic conductivity of 1.2 x 10^{-4} cm/s.

- Borrow sources BS-02 and BS-03 were classified as clayey-gravels with hydraulic conductivities of 6.2 x 10^{-4} cm/s and 2.5 x 10^{-4} cm/s, respectively.

- Approximately 15,000 cubic yards of borrow source material was identified onsite (BS-02 and BS-03), although more colluvial (BS-03) material is available, if necessary.

- There is an unlimited supply of silt material at BS-01, although this material lacks plasticity and may be unsuitable for cover material.

- All three borrow sources are chemically suitable for plant growth.

4.0 CONCEPTUAL CLOSURE DESIGN

This section provides an overview of specific reclamation strategies for each mine source component. Closure strategies for the following components are presented in this section:

- Heap-Leach Pads and Draindown Water
- Process Ponds
- Waste Rock Pile
- Facility Debris Containment
- Miscellaneous Facilities (Pit and Water Wells)
- Post-Closure Monitoring

The primary objectives of the reclamation strategy are to provide physical and chemical stabilization of mine source components to help ensure that waters of the State are not degraded and to help ensure that environmental risk factors are addressed and minimized to the extent possible. None of the reclamation strategies considered will result in a consumptive use of groundwater. Therefore, the concern for reclamation with regard to waters of the State is to protect groundwater quality and achieve physical and chemical stabilization of mine source components. With regard to environmental risk, the potential for direct and indirect risk to wildlife and humans utilizing these areas is addressed. Other reclamation objectives include protecting public safety, providing a final landform compatible with natural surroundings and promoting revegetation.

For each component listed above, a preferred reclamation alternative is presented. For some components (i.e., the waste rock pile), alternative reclamation scenarios are also discussed. The overall, preferred reclamation strategy for the Site is illustrated in Figure 4-1, *Conceptual Closure Design.*

4.1 HEAP-LEACH PADS AND DRAINDOWN WATER

Based on the physical and chemical data for the heap-leach pads and draindown waters, the following reclamation strategy was developed to stabilize the pads, limit infiltration and manage draindown waters from the pads:

- Regrade the pads to 3(H):1(V) slopes to limit erosion
- Develop a cover system for the pads to promote evapotranspiration and reduce infiltration
- Route draindown water from both pads to an ET basin
- Construct a leachfield downgradient of the ET basin for potential overflow

Each of these components is discussed in more detail in the following sections.

4.1.1 Heap-Leach Pad Regrading and Cover Design

Both heap-leach pads will be regraded to 3(H):1(V) side slopes to reduce erosion and promote runoff. The regraded pad designs are shown in Appendix G, *Heap-Leach Pad Regrade Design*. A cut-fill design is utilized, such that the majority of the regraded footprint is contained on the existing liner. The pads and covers are designed to direct meteoric water runoff off of the pads. Draindown water infiltrating through the pads will be contained on the liner and routed to the crushed ore pond, which will be converted to an ET basin (Section 4.1.2). A soil cover will be placed on the heap-leach pads to reduce infiltration, thereby limiting the volume of water handled by the ET basin. With regard to borrow source, it was determined based on cost, availability and soil quality that the colluvial material from borrow source BS-03 would be excavated for reclamation needs. The SoilCover model was used to evaluate a range of soil covers for the ability to promote ET and inhibit infiltration through the pads. The SoilCover model and results are discussed in Sections 4.1.1.1.

4.1.1.1 SoilCover Modeling

SoilCover is a coupled unsaturated flow and evapotranspiration model developed by the University of Saskatchewan (Geo-Analysis 2000). The model is a one-dimensional finite element package that simulates transient moisture and energy conditions within a soil section. The model uses a physically-based method for predicting the exchange of water and energy between the atmosphere and a soil surface. SoilCover predicts the evaporative flux from a saturated or an unsaturated soil surface on the basis of site-specific conditions involving three major variables: atmospheric conditions, soil properties associated with water transmission and storage and influences due to vegetation. Details of the SoilCover model that were developed and utilized for the heap-leach pad covers, including input parameters and model run descriptions, are provided in Appendix H, *SoilCover Model*, along with a complete description of algorithms used in the model.

<u>Approach and Input Parameters</u>

Infiltration through the soil section was modeled using an average weather year based on precipitation at the Ely, Nevada weather station. Based on 54 years of record, average precipitation at the Ely, Nevada station is 9.29 inches. Data from 1979 was used to represent an average year with an annual precipitation of 9.23 inches. Modeling was conducted on a water year basis (October 1 through September 30). Model simulations were conducted for the ROM and crushed ore heap-leach pads. Each pad was modeled using cover material from the on-site borrow source, BS-03. The following cover thicknesses were modeled: 0.5-, 1.0-, 1.5-, 2.0-, 3.0-foot cover thicknesses. Parameters were defined for the cover material (BS-03), crushed ore pad and ROM pad using site-specific data. A summary of properties for the three materials is given in Table 4.1, *Soil Properties Used in SoilCover Modeling*. Geotechnical and hydraulic data were collected during the November 2002 field event; laboratory results for these parameters are provided in Appendices C and D.

TABLE 4.1
SOIL PROPERTIES USED IN SOILCOVER MODELING

Property	Borrow Soil[1]	Run-of-Mine	Crushed Ore
Porosity	0.510	0.515	0.510
Specific Gravity	2.81 g/cc	2.77 g/cc	2.69 g/cc
Saturated Hydraulic Conductivity	2.5 X 10^{-4} cm/s	9.6 X 10^{-2} cm/s	5.9 X 10^{-2} cm/s

Notes:
[1] Sample BS-03 material properties used for soil cover
Grams per cubic centimeter = g/cc
Centimeters per second = cm/s

Weather data included temperature, relative humidity, solar radiation, precipitation and wind speed. All weather data are from the Ely, Nevada weather station. Snow pack was handled by accumulating precipitation during the snow pack period and then entering snow melt as precipitation during the snow melt period. The dates were determined based on snow depth data from the Ely, Nevada weather station.

Vegetation data included growing season, root depth, wilting and moisture limiting points and Leaf Area Index (LAI) for the plants on the cover. The LAI was represented as poor grass, or a minimum ground cover, for all simulations. The growing season used in the modeling ran from March 15 to September 30. These dates were chosen to represent the period when the majority of plants would be active. Plant root depth was represented at 12 inches for each simulation.

To reduce any potential effect from initial conditions, modeling runs were completed by simulating ten consecutive years with the same input data set and analyzing the output data from the last year of the simulation.

4.1.1.2 Modeling Results

Infiltration results for the SoilCover modeling are presented in Table 4.2, *SoilCover Model Results.* Infiltration was monitored in the model at a point just below the contact between the cover and the top of the heap-leach pad material. Water infiltrating past this point is assumed to pass through the pad material and discharge as draindown from the pad. In practice, some of this water would actually be evapotranspired, and therefore the infiltration/draindown results from the model are considered to be conservative.

Table 4.2 summarizes resulting runoff and infiltration/draindown estimates for various soil cover thickness. These results are plotted on Figure 4-2, *SoilCover Model Results.* As depicted in this figure, the majority of infiltration reduction is achieved with an 18-inch cover thickness. Increased cover thickness beyond this point does not result in an appreciable decrease in infiltration. Therefore based on the model results, an 18-inch soil cover is proposed for the heap-leach pads.

Figure 4-2
Soil Cover Model Results
Golden Butte Heap-Leach Pads

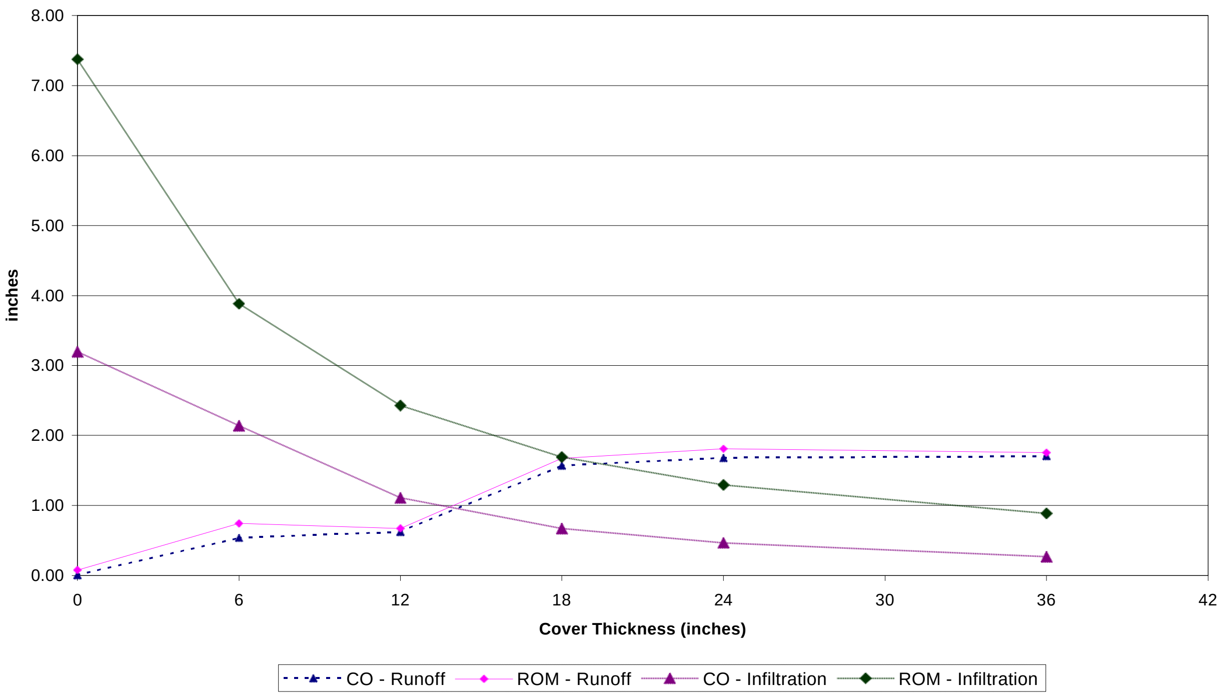

TABLE 4.2 SOILCOVER MODELING RESULTS - HEAP LEACH PADS GOLDEN BUTTE CLOSURE PLAN						
Leach Pad Model Run	**Cover Depth (in)**	**Precipitation (in)**	**Evaporation (in)**	**Transpiration (in)**	**Runoff (in)**	**Infiltration (in)**
CO - No Cover	0	9.23	10.16	0.00	0.01	3.20
CO - 6 inch cover	6	9.23	7.75	0.29	0.54	2.14
CO - 12 inch cover	12	9.23	7.99	0.42	0.62	1.11
CO - 18 inch cover	18	9.23	7.19	0.32	1.57	0.67
CO - 24 inch cover	24	9.23	7.12	0.32	1.68	0.47
CO - 36 inch cover	36	9.23	7.18	0.32	1.71	0.27
ROM- No Cover	0	9.23	2.55	0.00	0.08	7.38
ROM - 6 inch cover	6	9.23	4.75	0.20	0.74	3.88
ROM - 12 inch cover	12	9.23	6.20	0.25	0.67	2.43
ROM - 18 inch cover	18	9.23	5.86	0.20	1.67	1.69
ROM - 24 inch cover	24	9.23	6.07	0.19	1.81	1.29
ROM - 36 inch cover	36	9.23	6.47	0.23	1.76	0.88
Total - No Cover	0	9.23	12.71	0.00	0.08	10.57
Total - 6 inch cover	6	9.23	12.50	0.49	1.28	6.02
Total - 12 inch cover	12	9.23	14.18	0.67	1.30	3.54
Total - 18 inch cover	18	9.23	13.05	0.52	3.25	2.36
Total - 24 inch cover	24	9.23	13.19	0.51	3.49	1.76
Total - 36 inch cover	36	9.23	13.65	0.54	3.46	1.15

Notes:
Model results are presented for the final year of a ten-year simulation (9.23 inches of precipitation per year).
Cover material in each model run is BS-03 (onsite borrow source).

The resulting infiltration/draindown through the ROM and crushed ore pads (based on the 18-inch cover model results) is estimated to be 1.69 and 0.67 inches per year, respectively (compared to 7.38 and 3.20 inches per year, respectively, with no cover system). Applying the reduced infiltration rates (a total of 2.36 inches per year) to the regraded pad surface areas (a total of approximately 16 acres) results in a total average draindown rate of approximately two gallons per minute.

4.1.1.3 Evapotranspiration Basin and Infiltration Field (Draindown Water Management)

Draindown waters from both pads will be routed to the crushed ore pond, which will be converted to an ET basin. Construction of the ET basin is described below. The ET basin will be used to reduce draindown water through evaporation and transpiration from a revegetated soil cover constructed in the pond. This will be an effective method for managing draindown water given the anticipated low-levels of discharge from the pads (combined average of approximately two gpm). Excess water produced during short-term, elevated flow, large precipitation events or reduced ET periods will be stored in the basin until capacity is reached, after which water will overflow to an area west of the pond. This area will be prepared and converted to an infiltration field consisting of a series of trenches and infiltration chambers. The inflow to the ET basin will be designed with a port to allow future installation of a wildlife guzzler, if water quality conditions permit.

The crushed ore pond will be drained of water and the sludges will be transferred to the barren pond for permanent containment and closure. The original pond liner will be left intact. The ET basin will be constructed in the pond by placing fill material (borrow source BS-03) to within approximately four feet of the crest of the pond embankment. A two-foot gravel layer will be placed on top of the backfill and draindown water will be distributed through perforated pipes placed within the gravel layer. The gravel material will be obtained either from an off-site source or alternatively may consist of material excavated from the crushed ore pad. A two-foot layer of soil from borrow source BS-03 will be placed above the gravel layer and vegetated. A geotextile separator will be placed between the gravel and the soil material to prevent soil movement into the gravel. Draindown water will be distributed throughout the gravel and drawn upward into the soil layer to the active evapotranspiration zone. A piezometer will be placed in the ET basin to monitor moisture conditions (i.e., water depth) and water quality in the basin Overflow piping, placed within six inches of the embankment crest, will control water elevations in the basin. Both the inflow and outflow piping will be fit with shut-off valves and sampling ports. The fence that currently exists around the crushed ore pond (future site of the ET basin) will be repaired, as necessary, to prevent wildlife grazing. A schematic of the ET basin system is provided in Figure 4-3, *ET Basin.*

The ET basin is designed to manage normal draindown from the pads through the evapotranspiration capacity of the basin. An estimate of this capacity may be approximated by adjusting the reported pan evaporation for the area of 48 inches per year (reported in Ely, Nevada) by a coefficient of 0.9 for a resulting estimate of evapotranspiration of 43 inches per year. Multiplying this rate by the basin area of 52,000 square feet, results in an evapotranspiration capacity of 186,000 cubic feet per year, or approximately 2.6 gpm. Based on the results of the SoilCover model, the average draindown rate from the covered pads will be approximately 2.0 gpm. Therefore, under average climatic conditions, the ET basin should provide sufficient evapotranspiration capacity for the draindown waters. However, during large storm events, periods of high draindown flows and/or low evapotranspiration periods, overflow from the ET basin may periodically occur. In order to evaluate this, extreme precipitation models were run on the 18 inch cover for both the ROM and crushed ore pads. These models used precipitation and temperature data from the 1967 water year (annual precipitation of 15.6 inches). Results of the extreme precipitation scenario are presented in Table 2 of Appendix H. These results show that total infiltration through the pads would increase only slightly to 2.55 inches per year (a nominal difference of 0.19 inches per year), corresponding to a total flow increase of 0.16 gpm to the ET basin. Increases in evaporation, transpiration and runoff account for the remainder of the additional precipitation.

Also, in order to estimate the necessary storage capacity of the ET basin, the SoilCover model was used to model monthly evapotranspiration from the vegetated soil layer (on the surface of the ET basin) during an average rainfall year including draindown from the covered pads. The model was run with a 1½-foot, 2-foot or 3-foot soil layer above a saturated layer (representing the ET basin gravel layer). The total of the modeled monthly draindown flow from the pads plus normal precipitation was applied to the basin (inflow), and evapotranspiration (outflow) was calculated by the model each month. The difference between the inflow and outflow each month determined the required basin storage. Potential ET from the covers also varied as a function of the soil layer thickness. Based on the model results, it was determined that a two-foot soil cover layer above the gravel layer provided adequate ET and storage to handle draindown flows during average precipitation years.

Potential overflow water discharged from the ET basin will be managed using a subsurface infiltration field constructed in the area to the west of the pond. The infiltration field will be constructed using a series of trenches and infiltration chambers. A schematic drawing of the infiltration field and a cross-section view of the infiltration chambers are presented in Figure 4-4, *Infiltration Field Schematic* and Figure 4-5, *Infiltration Field Cross-Section*, respectively. The depth and configuration of the trenches will be sufficient to penetrate the shallow caliche layer. The trenches will be covered with surface material and the areas will be revegetated. As shown in Figure 4-4, a flume, instrumented with a pressure transducer and data logger, will be installed at the outlet of the ET basin to continuously monitor flow to the infiltration field. In addition, a piezometer will be installed in the area of the infiltration field for the purpose of monitoring.

4.1.3 Risk Evaluation and Groundwater Protection

The ET basin has been designed to reduce or hold discharge from the pads under average climatic conditions through evapotranspiration and storage capacity, as described in detail above. Discharge from the ET basin is generally not expected; however, the possibility exists for overflow from the ET basin during extreme climatic events. The potential impacts of ET basin overflow in terms of surface water impacts, ecological concerns, phytotoxic effects and groundwater protection are discussed below.

As discussed in Section 3.1.3, draindown water from the pads is slightly alkaline and contains high TDS (mostly sulfate, nitrate, sodium, chloride, calcium and magnesium). Currently, the concentration of WAD cyanide is slightly above the Nevada standard. Trace element concentrations that are in exceedance of Nevada standards include antimony (up to three orders of magnitude above the EPA drinking water standard for groundwater protection), arsenic (an order of magnitude above the Nevada standard), and selenium and thallium (only slightly in exceedance of the Nevada standards). The draindown water will be routed to the ET basin where, under reducing conditions, it is possible that water quality may improve (with regard to metals concentrations) as a result of metals precipitation as sulfide minerals. Also, plants within the fenced ET basin cover may uptake some of these trace elements, further reducing contaminant load. The ET basin will be completely fenced with an 8-foot chain link fence (gated and locked by BLM), which will preclude access to all large grazing animals (deer and elk) and most rabbits, thereby protecting wildlife. This fence will be maintained by BLM for many years; however, BLM may conduct plant tissue testing in the ET basin to determine the need for the fence into perpetuity.

The trace elements of potential concern to wildlife and plants include antimony, arsenic, selenium and thallium. Antimony is non-essential to plants but can be readily taken up by roots when in soluble forms in soils (Kabata-Pendias and Pendias, 1992). It therefore has the potential to act as a plant contaminant to wildlife receptors. A mean antimony concentration in terrestrial plants has been reported at 0.06 mg/kg. However, antimony concentrations in the range 7 to 50 mg/kg are reported for trees and shrubs growing in mineralized areas (Kabata-Pendias and Pendias, 1992). The maximum tolerable level in plants that serve as forage for domestic animals is reported to range 70 – 150 mg/kg (NAS, 1980). Antimony toxicity to plants has been described as moderate, although there are no reported environmental cases (Alloway, 1990). With regard to toxicological effects to animals consuming plants with elevated antimony levels, there is limited information. However, health effects resulting from exposures in animals through drinking water with elevated antimony concentrations include weight loss, liver damage and hematological effects (ATSDR, 2003).

Arsenic uptake in terrestrial plants is generally low, and therefore uptake by wildlife through this source is also considered low. Phytotoxic effects of arsenic vary between species, but have been reported at contaminated sites (Alloway, 1990). Concentrations of thallium and selenium in the overflow water are only slightly above standards; however uptake of these elements by terrestrial vegetation has been documented (Alloway, 1990). Ingestion by domestic animals of seleniferous vegetation has resulted in a condition referred to as selenosis, which has detrimental health effects to the animal.

These potential effects are minimized due to the fact that overflows of basin water will be intermittent and relatively rare. Also, the infiltration field is incorporated in the design in order to facilitate infiltration of potential overflow. The infiltration galleries will be constructed below the caliche layer and approximately three to five feet below grade (depending on the depth to the caliche layer). Infiltration through the unsaturated alluvium will be in the downward direction and should be relatively rapid. Therefore surface water impacts are not expected, which would mitigate the potential risk to wildlife via the surface water ingestion pathway. Furthermore, as a result of subsurface infiltration of the water in the vertical direction, most plant root systems would not be in contact with this source. Exceptions may include junipers and sage; however these plants are generally not consumed by wildlife as compared to shallower rooted grasses.

Risk to the groundwater resource is also considered low. In order to evaluate the potential impact of occasional ET basin overflow to groundwater, the estimated travel time for infiltrating water to reach groundwater has been evaluated. According to the hydrogeologic information for the Site, groundwater in the vicinity of the pads is expected to occur near the contact between the alluvium and the underlying fractured volcanic rock. This expectation is due to observations from the East Water Well, where both the geologic contact and the water level occur at approximately 60 feet bgs (Alta Gold, 2000). According to the geologic logs for condemnation holes drilled near the heap-leach pads, the contact of alluvium with fractured volcanics in the vicinity of the heap-leach pads occurs at approximately 200 feet bgs. Therefore, the depth to groundwater near the proposed infiltration field is assumed to be approximately 200 feet bgs.

Overflow from the ET basin is only expected during short-duration storm events and/or flow surges. Therefore, it is assumed that there would be no permanent driving head on the infiltrating water through the unsaturated alluvium. The infiltration rate through the alluvium is therefore estimated based on the natural recharge rate of precipitation in this area of 0.5 inches per year. Based on the depth to groundwater and an assumed water content of the alluvium of 0.10, the travel time for infiltrating water to reach groundwater is approximately 480 years, as shown in the calculation below:

$$Tt\ (yr) = (\text{depth to gw (in)}) * (\text{water content of alluvium}) / (\text{infiltration rate (in/yr)})$$

$$Tt = (200\ ft \times 12\ in/ft) * (0.10) / (0.5\ in/yr) = 480\ yr$$

Because any overflow from the basins would be advanced through the alluvium by percolating precipitation, the overflow water would be subject to dilution. Furthermore, according to the results of column attenuation studies initiated by Alta Gold, there is some attenuation capacity of the alluvium with regard to antimony and arsenic (Alta Gold, 2000). Based on this evaluation, it is unlikely that any substantial adverse impacts to groundwater quality would occur as a result of periodic overflows from the ET basin.

4.2 PROCESS PONDS

Reclamation of process ponds includes addressing disposal of existing pond water and sludges and decommissioning the pond impoundments. The following reclamation strategy is proposed for the process ponds:

- Existing water from ponds will be spray-evaporated onto the heap-leach pads (except water from the fresh water pond which may be discharged to the ground surface).
- Sludges in the barren, ROM and crushed ore ponds will be tested using MWMP for Nevada Profile II parameters.
- Sludges from the crushed ore pond will be transferred to the barren pond, and sludges in the barren and ROM ponds will be contained within the existing pond liners for permanent disposal.
- The ROM and barren ponds will act as disposal areas for sludges, uncontaminated debris and/or contaminated soils.
- The ROM, barren, and freshwater ponds will be decommissioned and regraded to their approximate original contour.
- The crushed ore pond will be converted to an ET basin (as discussed in Section 4.1).

One sample of the sludge material from each of the ROM, crushed ore and barren ponds will be sampled and the MWMP leachate from the sludges will be analyzed for the Nevada Profile II parameter list (shown in Table 3.3). The crushed ore pond will be drained and the sludges transferred to the barren pond. The crushed ore pond will then be converted to an ET basin as discussed in Section 4.1. Water from the process ponds will be spray-evaporated onto the pads during daylight hours to promote evaporative loss of water.

The ROM, barren and fresh water ponds will be decommissioned in place. As needed, the ROM and barren ponds may act as landfills for uncontaminated construction debris. In addition, contaminated soils from the diesel tank/pad area may be transferred to the barren pond and contained within the liner for permanent disposal. Miscellaneous soil and debris removal and containment are discussed further in Section 4.5. Following transfer of sludge and facility debris to the ponds, each liner will be folded over and covered using material from the embankments. The reclaimed surfaces will be revegetated as directed by BLM.

4.3 WASTE ROCK PILE

Results from the site characterization indicated that low pH and high salt levels are inhibiting revegetation in some areas of the waste rock disposal area. No seeps were identified along the perimeter of the waste rock and no significant areas of erosion or instability were observed. Based on a screening-level risk assessment of metals concentrations in barren soils on the waste rock, there is no imminent or substantial risk to human health or wildlife. However, it is apparent based on agronomic standards as well as empirical evidence that vegetation will not be established in these soils. Due to budgetary constraints and the necessity for prioritizing alternatives at this Site, the preferred closure scenario does not include remedial action with regard to the waste rock pile barren areas.

Alternate Waste Rock Pile Reclamation Plan

In the event that additional funding becomes available for addressing the waste rock pile areas, a reclamation alternative has been developed and is described below. The estimated reclamation costs for this alternative are provided in Section 5.0. Based on the physical and chemical data for the waste rock pile, the following reclamation strategy was developed to promote revegetation, which will also result in reduced infiltration:

- Amend barren areas with hydrated lime and crushed limestone
- Cover with six inches of borrow soil and revegetate

The area of acidic barren soil within the waste rock disposal area is estimated as nine acres. Based on geochemical modeling, approximately eight tons per acre of hydrated lime is required to neutralize current acidity in the soils (based on MWMP leachate analysis of sample WRB). An additional 57 tons per acre of crushed limestone would conservatively be required to neutralize future acid generation. This value is based on the AGP of these soils as calculated from the total sulfur content. This estimate considers potential acidity resulting from pyritic-sulfur, sulfate-sulfur and residual sulfur and is therefore a conservative estimate. Applying a six-inch soil cover will require approximately 7,260 cubic yards. These areas would then require revegetation, as per BLM guidelines. Information and guidance from BLM regarding revegetation in Nevada is included in Appendix I, *Nevada BLM Revegetation Information.*

4.4 FACILITY DEBRIS REMOVAL AND CONTAINMENT

Existing facilities and site debris will be removed and/or contained following NDEP and BLM guidelines, as described below:

<u>Recyclable Materials</u> – Materials such as piping and other recyclable materials will be used in the reclamation, as required, or stored on-site for potential salvage and recycling. An onsite storage area will be designated for recyclable materials.

<u>Uncontaminated Materials</u> – Materials in this category may include the following:

- Concrete and masonry debris
- Wood
- Miscellaneous non-economic metals
- Glass, plastics and other trash

Uncontaminated materials will be broken up, as necessary, and transferred to the ROM and/or barren ponds for permanent disposal. These ponds will be decommissioned as described in Section 4.2. This action will require a Class III landfill permit from NDEP.

<u>Contaminated Materials</u> – Soils potentially impacted by TPH exist in the vicinity of the diesel tank (removed in 2002) and pad. These soils will be tested for TPH, and contaminated soils (TPH concentration above 100 mg/kg) will be transferred to the barren pond and contained within the liner for permanent disposal. The liner will be folded over the sludges and contaminated soils, and the area above and surrounding the barren pond will be regraded as described in Section 4.2.

4.5 PIT AND WATER WELLS

Additional berming and signing around the pit is proposed to limit access and protect public safety. Work will be conducted under the guidance of BLM.

Water rights for the East and West Water Wells have transferred ownership. No action will be performed with respect to these wells.

4.6 POST-CLOSURE MONITORING

Post-closure monitoring will take place for a period of three years after completion of reclamation activities. Post-closure monitoring reports will be submitted on an annual basis. The following components will be included in the post-closure monitoring plan:

- ET basin water flow and water quality monitoring
- Vegetation monitoring on reclaimed surfaces
- Physical assessment of regraded heap-leach pads
- Assessment of efficacy of fluid management system

Water quality monitoring for the ET basins will consist of water level monitoring in the piezometer, flow measurements at the inflow and outflow (if flowing) to the basin, and collection of water samples from each of these locations where water is present. The water samples will be analyzed for Nevada Profile II parameters and total cyanide (as listed in Table 3.3).

4.7 ENVIRONMENTAL ASSESSMENT

Following approval of the Closure Plan, an environmental assessment will be prepared for the Site to assess the potential environmental impacts from the proposed action.

5.0 CLOSURE COST ESTIMATE

5.1 RECLAMATION BOND

A reclamation bond was posted by Alta Gold for the Golden Butte Mine. In 1995, reclamation was initiated in accordance with the Golden Butte Reclamation Plan (Alta Gold, 1993). The primary activities included rinsing the heap-leach pads and revegetation of the waste rock pile. However, due to bankruptcy, Alta Gold did not complete reclamation. Bond money remains for the completion of reclamation work in the amount of $340,000.

5.2 RECLAMATION COST ESTIMATE

A preliminary cost estimate has been prepared for the proposed reclamation approach for each mine component. This cost estimate should be considered preliminary and based on the current understanding of site conditions and available resources. The following sections present a brief description of the costs and costing development. Details of these costs are summarized in Table 5.1, *Golden Butte Closure Cost Estimate.* Supporting information is provided in Appendix J, *Closure Cost Estimate*.

5.2.1 Heap-Leach Pad Reclamation

Heap-leach pad reclamation will consist of re-grading the heap-leach pad side slopes to 3(H) to 1(V) slopes. The regrade plan for each pad is provided in Appendix G. Based on these designs, FPC software was used to calculate production costs (Appendix J) of $63,000 for the earthwork. With regard to borrow source for covering the pads, it was determined based on cost, availability and soil quality that the colluvial material from borrow source BS-03 would be excavated for use as the soil cover on the pads. Revegetation of the pads will be directed by BLM; the revegetation cost estimate includes seeding, mulching and soil amendments. The estimated cost for placement of the proposed, 18-inch soil cover with revegetation on both pads is $219,000. (The cost for placement of an 12-inch soil cover with revegetation is $167,000.) The total cost for the heap-leach pad reclamation is $282,000.

The ET basin will be constructed in the crushed ore pond as described in Section 4.1.2. The estimated cost to have gravel (unwashed) delivered to the Site was quoted at $40.00 per cubic yard, resulting in a total cost of $122,000 for the gravel layer in the basin. An alternative source for the gravel layer may be to use material directly from the crushed ore pad. This would significantly reduce the cost for construction of the basin. Costs for the leachfield assumes a series of trenches and infiltration chambers placed below the caliche layer within the soil. The total cost for constructing the ET basin and leachfield is approximately $171,000 (assuming gravel from an off-site source).

5.2.2 Process Ponds

The total cost for decommissioning the process ponds is estimated to be $25,000, which includes the following:

- Analytical testing of three sludge samples for MWMP Nevada profile II parameters and total cyanide; and

- Spray evaporating pond water from the ROM and crushed ore ponds (2.5 feet of water per pond was assumed). For the purpose of costing, it was assumed that the barren pond is dry.

TABLE 5.1
GOLDEN BUTTE CLOSURE COST ESTIMATE
GOLDEN BUTTE CLOSURE PLAN

Direct Capital Costs	Area	Amount	Unit	Unit Cost	Cost
1A.HEAP-LEACH PAD RECLAMATION					
Regrade Pads (3:1 Side Slopes)					
ROM Leach Pad	Regrade Top	33,300	CY	$0.61	$20,316
	Regrade Sideslopes	38,116	CY	$0.44	$16,610
Crushed Ore Leach Pad	Regrade Top	34,266	CY	$0.49	$16,725
	Regrade Sideslopes	29,603	CY	$0.33	$9,675
				Total	**$63,327**
Soil Cover Leach Pads (1.5 ft cover) (On-site Borrow Source BS-03)[1]					
ROM Leach Pad	18" Cover Top	17,348	CY	$1.96	$34,002
	18" Cover Sideslopes	21,949	CY	$1.96	$43,019
	Revegetate	707,336	SF	$0.045	$31,830
Crushed Ore Leach Pad	18"Cover Top	19,048	CY	$1.94	$36,954
	18" Cover Sideslopes	20,959	CY	$1.94	$40,660
	Revegetate	720,129	SF	$0.045	$32,406
				Total	**$218,871**
	TOTAL LEACH PAD RECLAMATION COSTS[1]				**$282,198**
1B. ET BASINS					
ET Basin (CO Pond)	Backfill Pond	7,133	CY	$2.20	$15,693
	Gravel Layer (2 feet)	3,048	CY	$40.00	$121,920
	Alternate Gravel (CO Pad)	3,048	CY	$1.96	$5,974
	Geotextile Separator	44,625	SF	$0.18	$8,033
	Soil Cover (2 ft)	3,586	CY	$2.20	$7,889
	Revegetate	52,192	SF	$0.045	$2,349
	Piezometer	1	EA	$100.00	$100
				Total	**$155,983**
Leachfield					
	Trenching	1824	CY	$3.22	$5,873
	Infiltration Chambers	158	EA	$22.00	$3,476
	End Caps	10	EA	$5.00	$50
	Piping and Plumbing	1	LS	$200.00	$200
	Piezometer	1	EA	$100.00	$100
	Flume	1	EA	$715.00	$715
	Transducer w/ Data Logger	1	EA	$1,000	$1,000
	Backfill	1824	CY	$1.57	$2,864
	Laborer	20	HR	$24.87	$497
				Total	**$14,775**
	TOTAL ET BASIN AND LEACHFIELD RECLAMATION COSTS				**$170,758**
2. PROCESS PONDS					
Pond Water Transfer	Spray Evaporate to Pads	1	EA	$3,094	$3,094
Sludge Testing	MWMP Nevada II Profile	3	EA	$350.00	**$1,050**
Sludge Transfer	CO pond to barren pond	1	EA	$5,193	$5,193
				Total	**$9,337**
ROM Pond Decommission	Backfill Pond	9,494	CY	$0.54	$5,149
	Revegetate	131,035	SF	$0.045	$5,897
				Total	**$11,045**
Barren Pond Decommission	Backfill Pond	5,478	CY	$0.54	$2,971
	Revegetate	23,540	SF	$0.045	$1,059
				Total	**$4,030**
Fresh Water Pond Decommission	Backfill Pond	800	CY	$0.54	$434
	Revegetate	3,440	SF	$0.045	$155
				Total	**$589**
	TOTAL POND RECLAMATION COSTS				**$25,001**

TABLE 5.1
GOLDEN BUTTE CLOSURE COST ESTIMATE
GOLDEN BUTTE CLOSURE PLAN
(Continued)

Direct Capital Costs	Area	Amount	Unit	Unit Cost	Cost
3. WASTE ROCK PILE - ACIDIC BARREN AREAS					
Lime Amendment (9 acres barren, acidic soil)					
Hydrated Lime Quantity (Portlandite) (8 Tons per Acre Requirement)					
	Total $Ca(OH)_2$ Required	72	T	$101.00	$7,272
	Labor	5	DY	$484.80	$2,424
	Equipment				$1,900
				Total	**$11,596**
Crushed Lime (57 Tons per Acre Requirement)					
	Total $CaCO_3$	513	T	$21.00	$10,773
	Labor	5	DY	$484.80	$2,424
	Equipment				$1,900
				Total	**$15,097**
Soil Cover	Soil Cover (6")	7,260	CY	$2.20	**$15,972**
	Revegetate	392,040	SF	$0.045	**$17,642**
	TOTAL WASTE ROCK PILE RECLAMATION COSTS				**$60,307**
4. FACILITY AND DEBRIS CONTAINMENT					
On-site Uncontaminated Landfill					
Misc materials transferred to ROM Pond prior to decommissioning					
	Excavator	5	DY	$1,500	$7,500
	Haul Truck	2	DY	$1,000	$2,000
				Total	**$9,500**
Contaminated Materials					
Contaminated soils transferred to barren pond					
	Soil Testing (TPH)	8	EA	$52.00	$416
	Excavator	2	DY	$1,500	$3,000
	Haul Truck	2	DY	$1,000	$2,000
				Total	**$5,416**
	TOTAL FACILITY/DEBRIS REMOVAL RECLAMATION COSTS				**$14,916**
5. OPEN PIT / WATER WELLS					
Water Wells	Ownership transferred				$--
Pit	Berming (dozer)	10	HR	$150.00	**$1,500**
	Signage (BLM)				TBD
Subtotal Direct Capital Costs					**$494,373**
Indirect Capital Costs					
	Mobilization & Demobilization[2]	15%	of direct costs		$74,156
	Contingency	15%	of direct costs		$74,156
	Overhead	10%	of direct costs		$49,437
	Profit	5%	of direct costs		$24,719
Subtotal Indirect Capital Costs					**$222,468**
Post Closure Costs					
6. POST-CLOSURE MONITORING (Quarterly monitoring for three years = 12 site visits)					
	Travel and Expenses (2 person-day)	24	DY	$500.00	$12,000
	Annual Water Sampling - ET Basins - 3 samples	36	EA	$250.80	$9,029
	Reveg Monitoring				$ -
Subtotal Post Closure Costs					**$21,029**
TOTAL RECLAMATION COST ESTIMATE[3]					**$737,870**

TABLE 5.1 GOLDEN BUTTE CLOSURE COST ESTIMATE GOLDEN BUTTE CLOSURE PLAN (Continued)		
Other Site Costs		
7. ENVIRONMENTAL ASSESSMENT		
Cost dependent on scope		**$ 10,000 - $30,000**
Notes: 1. The estimated cost for applying a 12" cover (including revegetation) is $167,326 (as opposed to $218,871 for an 18" cover). This would reduce the heap-leach reclamation cost by $51,545. 2. Mobilization and demobilization includes environmental controls (I.e. site sediment controls, etc). 3. Total Reclamation Cost does not include waste rock pile reclamation or an environmental assessment.		
AC = Acre	HR = Hour	SF = Square feet
CY = Cubic yard	LF = Linear foot	T = Tons
DY = Day	LS = Lump sum	T/AC = Tons/acre
EA = Each	MI = Miles	

- Transferring sludge from the crushed ore pond to the barren pond; and
- Folding in liners, re-grading and revegetating the ROM, barren and fresh water ponds.

5.2.3 Waste Rock Pile (Alternative)

The proposed alternative for the waste rock pile at this time is no action, as described in Section 4.3. In the event that additional funding becomes available for addressing the waste rock pile areas, costs have been developed for the following alternative:

- Amend barren areas (nine acres) with hydrated lime and crushed limestone; and
- Cover with six inches of borrow soil and revegetate.

Based on geochemical modeling (PHREEQC), approximately eight tons per acre of hydrated lime would be required to neutralize current acidity in the soils (based on MWMP leachate analysis of sample WRB). An additional 57 tons per acre of crushed limestone would conservatively be required to neutralize future acid generation (based on the AGP of these soils, conservatively calculated from total sulfur content). Costs for obtaining and applying the soil amendments is detailed in Appendix J. Applying a six-inch soil cover (obtained from the on-site borrow source) to the acidic areas would require approximately 7,260 cubic yards, and these areas (nine acres) would require revegetation. The total cost for this reclamation alternative is approximately $60,000.

5.2.4 Facility and Debris Containment

Approximate costs are provided for transferring uncontaminated materials (concrete foundations, building materials, wood, non-recyclables, miscellaneous debris) to either the barren or ROM ponds. This cost assumes five days of excavator work and two days of haul truck use. Costs for addressing potentially contaminated soils include soil testing (eight samples for TPH analysis) and excavator/haul truck usage for two days. It is assumed that transference of recyclables will be at no cost to the project. The total cost for facility and debris removal and containment is estimated to be $15,000.

5.2.5 Open Pit/Water Wells

No cost has been associated with the water wells. Additional berming around the pit assumes one day (ten hours) of dozer work for an estimated total cost of $1,500. It has been assumed that signs will be provided by BLM at their discretion.

5.2.6 Indirect Construction Costs

Additional indirect construction costs include mobilization/demobilization of equipment (15 percent of direct construction costs), contingency (15 percent), overhead (10 percent) and profit (5 percent). The total of these indirect costs adds approximately $222,000 to the final cost estimate.

5.2.7 Post-Closure Monitoring

Post-closure monitoring will consist of conducting Site visits on a quarterly basis for three years. Each Site visit assumes two persons for one day. Water samples will be collected from the ET basin during each visit, consisting of samples from the basin inflow (draindown water), the ET basin piezometer and the outflow (if flowing). These samples will be analyzed for the Nevada Profile II parameters and total cyanide ($250.80 per sample). The total cost over three years for monitoring is $21,000.

5.2.8 Environmental Assessment

The cost for the environmental assessment is variable depending on the final scope. The cost is estimated between $10,000 and $30,000 and is not included in the total cost estimate.

5.2.9 Total Cost for Proposed Closure Design

The total reclamation cost estimate is approximately $738,000. This estimate does not include waste rock pile reclamation or the environmental assessment.

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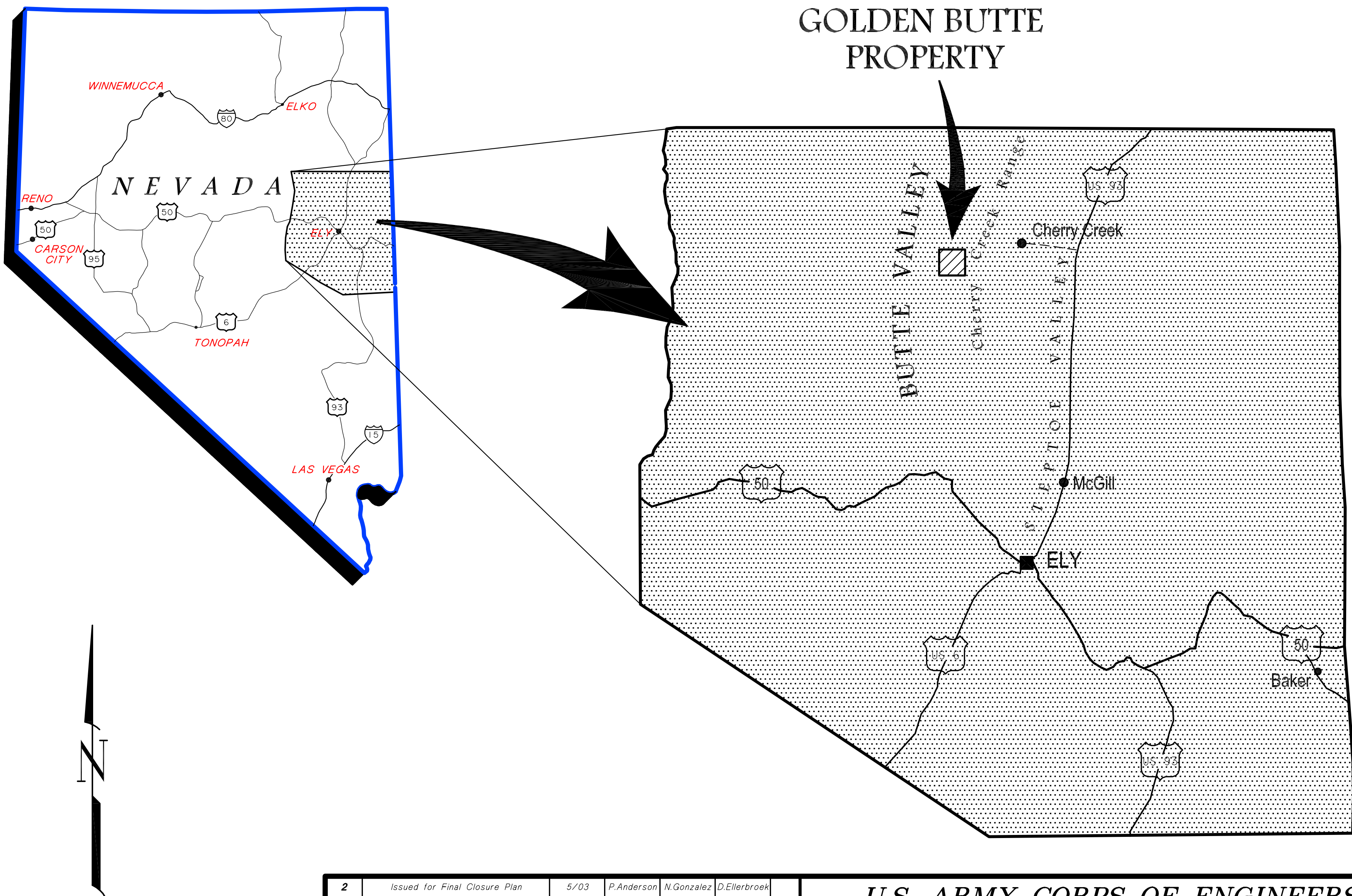

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REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
2	Issued for Final Closure Plan	5/03	P.Anderson	N.Gonzalez	D.Ellerbroek
1	Issued for Draft Closure Plan	3/03	P.Anderson	N.Gonzalez	D.Ellerbroek
0	Issued for Draft	06/02	J.Redmond	K.Conrath	J.Redmond

MWH

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AutoCAD FILE: 1-1 Genloc 5-03

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FIGURE No: 1-1

U.S. ARMY CORPS OF ENGINEERS
GOLDEN BUTTE CLOSURE PLAN

GENERAL SITE LOCATION

APPENDIX A

FIELD DOCUMENTATION AND PHOTOGRAPHS

FIELD SAMPLING DOCUMENTATION

FIELD NOTES

SAMPLING PHOTOTGRAPHS

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CLOSURE COST ESTIMATE DETAILS